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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. MEHREN *Editor*

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Dayton Meeting a Success

IN THE record of gratifying success made by the American Society of Civil Engineers in its Dayton meeting there lies far more than an isolated fact in the society's career. The meeting marks an epoch in the life of this great professional body. Long tied up in rather rigid and routinized practices, the society broke away from these and for the first time held a regular meeting away from headquarters. It took the meeting to the members out in the field. The response was a surprisingly large attendance and an intense interest. No one who was there entertains the slightest doubt that there will be similar response to other meetings of the kind. Thus Dayton ushers in a period of new vigor and vitality in the society's existence. There is no longer the doubt that for some time maintained itself, as to whether the common or garden member is or is not interested in the society's doings. He is; and he will respond with stimulating activity on his part to all genuine activity on the part of the society. In view of this manifest desire for leadership it is unfortunate that the board of direction was unable to reach definite conclusions as to any of the important administrative questions now before the society.

End of Miami Construction

DURING the current season the last work will be done on the Miami Conservancy District construction. The Dayton meeting was a fitting and quietly impressive valedictory, as was remarked by the most energetic and resourceful promoter of the project. So quickly has the work run along during the four-year construction period that it has attracted far less notice than it deserves. As a detail, it progressed to completion without incident or accident. One of its greatest distinctions, however, is that virtually every element of the work embodies new methods, research discovery, or development of better practice, to a degree that makes this one enterprise a splendid model. As it has been a great school for the chosen group of engineers who were engaged in it, so it will long be a school for all concerned with hydraulic engineering in any phase, and flood-protection in particular.

Flood Problem Appreciated

DURING the nine years since the disastrous flood in the Miami Valley the shadow of the great flood problem throughout the country has ever been discernible. But various obstacles prevented its full and general recognition; at first, perhaps, the newness of the problem, and later the distraction of the war. At Dayton, however, the flood problem came to occupy at least its true place of importance, and those who attended the meeting quite evidently received a lasting impression of what they had neglected to notice in the past. More truly today than ever, floods and protection against them constitute one of the great problems and responsibilities confronting the civil engineering profession. As yet the public at large has not come to realize the gravity of the situation. When engineers appreciate it, however, there is good foundation for the coming public understanding; and this foundation has now been laid.

Scientific Concreting

IT IS rare enough that over 400,000 cu.yd. of concrete is placed on one construction job to make the detailed story of how and where that concrete was placed worth while. For that reason the articles in this and the last issue on the Queenston-Chippawa project are valuable records. But the important feature of this Ontario concreting job is not its magnitude but the remarkable uniformity of concrete that was obtained over a stretch of thirteen miles with different materials and with nearly a score of concreting plants. These varied from the large central plants at the power house and Whirlpool turning out as much as 800 yd. a day to the little pavers which ran along under their own power on the canal bottom. All operations, however, were controlled by a single head who was concerned just as much with the source of material as with the mixing and placing and finally the testing. This central control is common enough nowadays but not often has the actual placing of the concrete been so responsive to the testing and investigative activity. The high degree of strength uniformly achieved justifies such scientific control.

Construction Federation

IT IS regrettable that the men of the construction industry did not turn out in large numbers at Chicago last week in order to profit by the excellent review offered at the meeting of the National Federation of Construction Industries of the factors entering into a construction revival. Had there been a large and enthusiastic assemblage it is possible that the conference might have had some influence on the construction situation. As it is, the only general benefit would seem to be the demonstration that the National Federation of Construction Industries as now formed cannot be made truly representative of the industry. It has been looked upon by architects, engineers, and contractors as a federation of materials manufacturers. Consequently, despite the earnest efforts of the officers of the federation these three classes have held aloof. Yet it was very apparent from the Chicago meeting that there is felt a widespread need for some body that will, as occasion demands, be able to bring together on a footing of equality all of the interests concerned with construction. In fact, it is understood that out of the Chicago meeting will come discussions aimed at either the re-organization of the federation or the constitution of a new body that will win the support of all parties. Should these projected discussions result in an effective organization there will be lasting benefit, though indirect, from the small meeting of last week.

Ultrademocracy or Mobexpertocracy?

POPULAR defiance of the advice of the California State Board of Health, of the city engineering department of Los Angeles and of eminent consulting engineers has resulted in the sewage-disposal complications that are set forth elsewhere in this issue. Three times in the last six years have the people of Los Angeles defeated proposed bond issues to meet a sewage disposal situation that was constantly growing more serious. A fourth vote has recently been ordered for Aug. 12. Its outcome will be awaited with interest. Meanwhile, the city is under an injunction against the discharge into a creek of excess sewage, beyond the capacity of the ocean outfall. The State Board of Health, the court that issued the injunction, and a committee of the local section of the American Society of Civil Engineers have each given advice, largely conflicting, designed to meet the emergency. This entire series of events at Los Angeles is without parallel in the whole history of sewage disposal in America. Could one delve widely and deeply enough into local conditions it might be found that quite other than engineering factors are responsible for the fact that a city that prides itself on its large and growing population, its blessings of nature and its democracy should make such a spectacle of itself as has Los Angeles. Can it be that the trouble is ultra-democracy—a distrust by the little-informed many of the specialized knowledge of the few? Or is it a case of "mobexpertocracy" such as was displayed in another California city not long ago (see *Engineering News-Record*, June 14, 1917, p. 563) when for some years Sacramento citizens preferred their own ideas rather than those of competent engineers as to what was the best plan for a new water supply but had so many different ideas that they could agree on none of them?

Menace of County Control

INDICATIONS are found in various sections of the country of an attempt to wrest control of highway construction from the states and return it to the counties. While the movement has not been organized, it has cropped out frequently enough to warrant concern on the part of state highway officials. County politicians have looked with envious eyes upon the large sums of money that are being spent under state control. With a slice of these funds at their own disposal opportunities for the distribution of patronage and for work by their contractor constituents would be rich indeed. During recent years the whole trend of highway legislation has been toward a centralization of control in the state highway departments and the organization of a properly qualified engineering corps to direct design and construction. Counties, as a general rule, are not in a position to give to highway work the efficient administration and skilled technical supervision which the state department can furnish. It has taken years to build up our state highway departments to their present point of efficiency, and action is now needed to forestall any movement having for its object the reversion of control from the state to its lower political subdivisions. The Federal Highway law, enacted last year, recognized the principle of a connected system of highways—as against the piecemeal construction of former years—and made the supply of federal aid dependent upon adequate state control. It would be a severe blow to highway development if the state control which it has taken so long to build up were weakened. The highway program of the states today involve such large sums of money that honest, impartial control of them is demanded. The state, not the county, is the agency to administer these funds and supply the skilled engineering supervision which road-building now demands.

Continuity of Construction Required

PREVIOUS cost records may prove highly unreliable as a guide to the cost of new work unless the relative efficiencies of the directing organizations are evaluated. If the work being taken as a guide was conducted by experienced foremen and crews and a new organization has to be assembled for the contemplated work, the old costs will be too low. These facts mean more than a warning to contractors to use caution in compiling bidding prices from the figures of costs kept on previous operations. Repeated creation of new organizations to direct construction is one of the cost-penalties of present contracting practice. Except for large construction companies, with country-wide operations, the foremen, machine operators and skilled workmen are assembled anew for each season's work. This will continue as long as six months of the year are idle time with most contractors. Winter construction is only an occasional practice. Also contracting is too specialized to permit many contractors to shift from their usual summer operations to the kind of work that can be done well in the winter. This is especially true of highway contracting. Few paved road contractors have the equipment or the experience to do winter building or tunneling or heavy excavation, and they, therefore, break up their organizations every fall and assemble new organizations every spring. Extension of the construction season and continuity of employment are contributions toward the revival of industry which engineers and contractors are called upon to undertake.

Mid-West Cement Boycott Off

ROAD building in the Middle West on a larger scale than ever before is assured. State contracts for cement which have been pending for a month or more have now been let and contracts for the individual mileages are being opened rapidly. The boycott, so called, of Wisconsin, Illinois, Indiana and Michigan against cement has been dropped, and that without material price concessions.

Michigan has signed up for 1,120,000 bbl., which will build about 340 miles. Illinois on April 6 announced the placing of 2,700,000 bbl., bringing the total purchase to 3,600,000 bbl., enough for its 1,000-mile program. On March 31 Illinois received bids on 95 miles of road. Indiana on April 6 added 110,000 bbl., to the 212,000 bbl. purchased in March and has yet to apportion an additional 200,000 bbl. to the various cement companies, enough to build about 150 miles. Wisconsin last month bought 1,500,000 bbl. for its 450-mile quota, of which more than 220 miles have been let to the individual contractors.

As these states, which are the principal ones that buy cement and furnish it to the contractors, each have as large or larger programs than ever before the road building stage in the Middle West is set for an unprecedented program.

The effect of the boycott on prices has been insignificant, but we may hear from it later. The price con-

cessions which were announced as the object of the boycott have not been secured. Where there have been sizeable concessions, they have been offset by the condition that the cement must be taken in large quantities early in the season and warehoused at the State's expense.

But there may be another result, shortage of cement in the late summer or fall, or a number of mills shut down part of their capacity on account of the boycott. We may, therefore, hear echoes of the boycott some months from now.

Just now the interesting fact is that the boycott has been lifted and that four of the states with large road programs are not to hold up their work any longer.

New Developments in Rock Tunneling

WITHIN recent years new conditions have developed in the West that have brought about a readjustment of hard rock tunneling methods. For the most part the changes have not been along the line of refining and perfecting old methods, the outstanding factors, rather, being the more positive call for speed arising from the economic demands of hydro-electric service, the advent of the mucking machine and the increase in size of tunnel heading sections. The demand for speed is doubtless the most important of these. While in some cases favoring speed over cost is fully justified, there is a fair chance through the use of modern methods and equipment that speed, the all important consideration, can be greatly increased without excessive cost, as is pointed out in the article by R. C. Starr in this issue. With both cost and speed thus involved by new conditions, the whole subject of hard rock tunneling methods comes up for readjustment.

The demand for speed is especially great in hydro-electric practice because tunnels are often the limiting factor in the time required to get new power projects into service. The need for water power has become more urgent in the West as oil prices have increased and rapidly growing communities and industries have created a power demand that brooks no delay. Agricultural development of the San Joaquin Valley in California, for example, was being held back because power for pumping irrigation water was not available. The Kerckhoff tunnel was the limiting factor in getting water on the land and the result was remarkable speed in driving that tunnel. A bonus was offered for all shots that pulled over 16 ft. and during the last ten days of the work a larger bonus was offered for the best record in an 8-hour shift. These inducements produced results; rounds over 20 ft. deep were pulled and the work was completed quickly enough to attain certain highly important objectives. Even so, the total costs on this tunnel were no more, according to Mr. Starr, who had charge of the work, than on other tunnels of the same size and driven under the same conditions but without the means used here to speed up the work.

Not all engineers will agree with this method of offering bonuses. It is pointed out, for example, that a bonus for special shots, or even for the best shift record, is apt (1) to breed carelessness in the amount of powder used, (2) to cause overbreakage, and (3) to encourage the endeavor to make a spectacular shot at the expense of progress on the following shift. The substitute suggested is a bonus for the highest monthly average or any plan that would encourage teamwork among the three shifts.

In the last year or two mucking tunnels by power shovel has gained popularity so rapidly that it is now standard on tunnels 17 ft. square or larger. Even steam shovels with cut-down booms and dipper sticks cannot be used to advantage in tunnels of less than 17 x 17-ft. section, and if the section required approaches this size it is not infrequently increased for the express purpose of permitting the use of power shovels. The moving of the larger yardage thus entailed is justified by the lower cost per yard. While this practice of making the tunnel larger than necessary works out very nicely in hard rock, it would unduly increase the cost if applied in formation that required timbering. The situation therefore suggests the need of something in between the present mucking machine and the steam shovel. Various types of mucking machines in common use are advantageous for tunnel sections up to about 12 ft. square. Beyond that and until the section becomes large enough for two machines or for steam shovels, there is a gap in which mechanical mucking is not now being applied to good advantage. In fact, in this range of 12 to 17 ft. hand mucking has occasionally been used as the most expeditious means available.

The mucking machines used in Western power-tunnel work are the same as those built for the mining field, where large tunnels are not common; in other words, the civil engineer is using equipment developed to suit the requirements of the mining engineer. In view of the amount of large power-tunnel work to be done in the West within the next few years—$250,000,000 worth, Mr. Starr says—attention to this need should be a profitable venture.

With good teamwork, now less common than formerly, crews are able to work to best advantage on short rounds, but with inefficient labor longer shots are more economical. Standard practice in Europe has been toward much shorter rounds than are used in this country. In the Loetschberg tunnel, for example, the practice was to use 4-ft. rounds. This is in striking contrast to the 20-ft. rounds in the Kerckhoff tunnel. Although the Kerckhoff job probably represents an extreme, yet the tendency is unmistakably toward long rounds. In the South Fork heading, the hardest rock on the Hetch Hetchy tunnels, where the tunnel width is slightly over 13 ft., the average pull is 12 ft. or a little more. As tunnel sizes increase, deeper holes can be drilled without making the central angle of the V-cut too sharp for the best powder effect. The large-size power tunnels now being built or projected are introducing new problems in drill design and the manufacture of drill steel.

With the present high mucking costs (whether by hand or machine) it is more important than ever to place and load holes so that the muck will be well broken up but at the same time piled close to the heading, where it can be handled economically. On this score a well known Western tunnel builder recently said, "It is a great mistake to fill drill holes with powder; the most economical basis is to load them for six-tenths of their depth. If the character of the rock is such that a hole of a certain depth cannot break it when six-tenths full of powder, the depth of the holes should be decreased until they can be so pulled."

Until recently rock tunneling was mainly a railroad operation and like most railroad engineering it tended to become over standardized. New requirements and new thought came with the big water tunnels and they are beginning to reflect on practice.

Modern Practice in Driving Western Hard-Rock Tunnels

A Discussion of Factors Affecting Size, Progress and Cost in Large Power Tunnels; Depth and Relation of Drill Holes, Heading and Mucking Methods

By R. C. Starr
Construction Engineer, San Joaquin Light & Power Corp.

IN THE construction of the large mileage of hard-rock tunnels that have been built for power purposes in the West within the last few years, no radically new methods of driving have been developed, but modern conditions and equipment have changed the importance of various factors bearing on cost and speed. The substitution of mechanical for hand mucking, for example, has changed the problem of determining economic sizes. Mucking with machines has affected the depth and relation of drill holes by placing a premium on that combination which would most effectively prevent the muck from scattering; while the expense attaching to extra movings of drill carriage or mucking machine has placed new penalties on "boots" that require re-shooting. Altogether, with the large savings that can now be effected by driving tunnels at high speed, good practice in hard-rock tunneling methods is now very different from what it was five years ago. In this article it is the author's purpose to record ways and means that have been found advantageous under present conditions and to discuss reasons for using certain methods in certain cases.

Power Intake Tunnels.—In the early development of the water-power resources of the West, many open ditches and flumes were constructed to carry the water from the intake to the head of the penstocks, but nearly all the water conduits built during the past ten years are tunnels, and tunnels will be built in the future in connection with hydro-electric development.

Five factors are largely responsible for this: (1) Nearly all economical hydro-electric projects yet undeveloped are in mountainous country, where slides, rolling rocks, and damage from forest fires make open ditches and flumes costly to maintain, and the uncertainty of their operation makes a higher percentage of reserve steam power necessary than is the case with hydro-electric plants whose water conduits are underground. (2) Due to the fluctuating daily load and the wide variation in summer and winter stream flow, a considerable part of the friction losses in the water conduits is saved by the use of pressure tunnels. (3) To decrease the amount of steam reserve power, which is steadily increasing in cost, due to the increasing price of oil, future hydro-electric developments will largely consist of plants with large storage reservoirs, which will store the flood waters and make them available during months of low stream flow. The entire available fluctuating head of the reservoir is made available at all times by the use of pressure tunnels. (4) Due to the length of time required for water to travel from the intake to the forebay, it requires considerable time for the load dispatcher to change the load on an open-conduit plant, and in case of trouble a considerable amount of water is wasted. Moreover, this type of plant cannot be used as a governing plant without a large forebay, which ordinarily is impracticable in mountainous country. (5) Due to advances in tunnel driving, the cost per foot of tunnels for given capacities has not increased so rapidly as the cost of flumes and open conduits.

Practically all important power companies of the Pacific Coast now have tunnels in service, under construction or proposed, in some cases all three. The amount to be spent in the next ten years in California alone for hydro-electric power development is conservatively estimated at $250,000,000 and it is safe to say that one-third to one-half of this will be expended on tunnels. In view of this situation, tunnel-driving methods warrant careful consideration.

All of the proposed tunnels on the Kings, Kern and San Joaquin Rivers, as well as those already built or under construction, have been in hard rock. The material encountered, almost entirely granite, required practically no timbering. The size of these tunnels is determined primarily by hydraulic conditions, but the relative cost of lined and unlined tunnels for equal capacities has caused the adoption of unlined pressure tunnels in every case where hard rock of good quality and not too badly fractured was encountered.

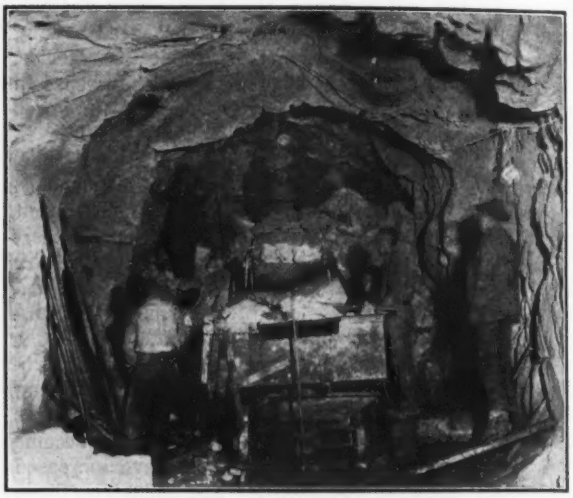


FIG. 1. TYPICAL HORSESHOE SECTION
Pneumatic mucking machine at work in 13½ x 14-ft. Kern River Tunnel, San Joaquin Light & Power Corp.

Fig. 2 gives curves showing comparative costs of lined and unlined tunnels for equal capacities in hard granite. The enormous saving to be made by adopting the unlined tunnel section is evident. The two curves shown are for tunnels in hard granite acting as pressure conduits, figured for the same friction losses. For the lined tunnels the value of n in Kutter's formula was taken as 0.015, while the corresponding value for unlined tunnels was 0.035. Actual tests showed that the value n increases slightly with the increase in size of conduits and varies from 0.012 to 0.015 for lined tunnels and from 0.030 to 0.033 for unlined sections.

Shape of Cross-Section.—The shape of the cross-section of lined pressure tunnels is based upon two considerations: (1) Cost of concrete lining and (2) economy in driving. As a result, two sections have been

FIG. 3. RADIAL DRILLING FROM PIONEER HEADING

largely adopted; the circular section, which requires no reinforcing in hard rock, and the horseshoe section, which does require reinforcing. The horseshoe section is more easily excavated with mucking machines, and for that reason is now being generally adopted.

Nearly all unlined rock tunnels used as water conduits are built with a comparatively flat arch, nearly vertical side walls, and a flat bottom, as this section is most easily drilled and mucked. To decrease the friction losses in unlined tunnels, it is very important that the drill holes on the top, bottom and sides of the tunnel be placed as nearly parallel with the finished walls as possible, and it is also important that as few "boots" as possible be left in the tunnel. Other things being equal, friction losses are usually less in tunnels where the drilling was done in a direction opposite to the flow of water. Uniformity in cross-section area throughout the tunnel also tends to lower the friction losses.

Face Methods.—All tunnels in hard rock which are over 14 ft. high and 10 ft. wide and require practically no timbering can be driven most economically and most rapidly by the heading-and-bench method, using steam shovels operated on compressed air. Two other methods, the straight-face method and the pioneer-heading method, were tried when the Kerckhoff power tunnels were driven in 1919 and 1920, and after six months' trial of all three, the heading-and-bench method was adopted at all headings. The pioneer-heading method was used by the Southern California Edison Co. in its large hard-rock tunnel on the Big Creek No. 8 power project; but it also is now adopting the heading-and-bench method in all tunnels as being the most rapid and economical.

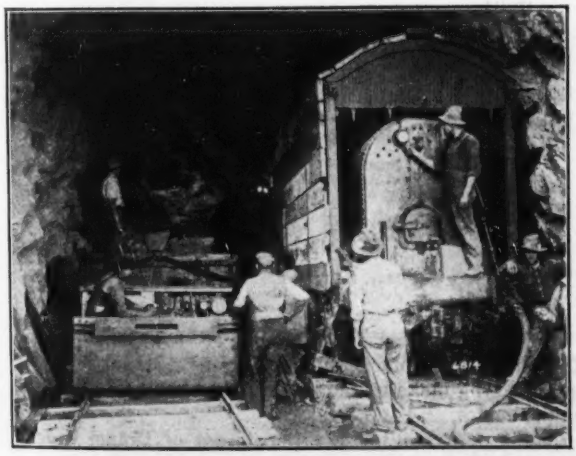


FIG. 4. STEAM SHOVEL MUCKING IN 20 x 20-FT. TUNNEL
Tunnel No. 7 of Southern California Edison Co. Note air hose to shovel and 2-in. plank housing.

Heading-and-Bench Method.—With the heading-and-bench method, the bench used should have a length of about two-thirds the tunnel width and should be about 10 ft. from the roof. The drillers, two to four in number, depending upon the size of the tunnel, and an equal number of chuck tenders (all of these should be able to run a drill, at least in an emergency) drill the heading holes with drills mounted on cross-bars or columns, while the muck from the preceding shot is mucked out. A steam shovel operated on air, if properly designed as to size of dipper, length of boom and dipper stick, will muck out any round in 5 to 8 hours, if proper electric locomotives and cars and track facilities are provided. The proper number of drills should therefore be operated in the heading so that the drilling of the heading will be completed by the time the mucking is done.

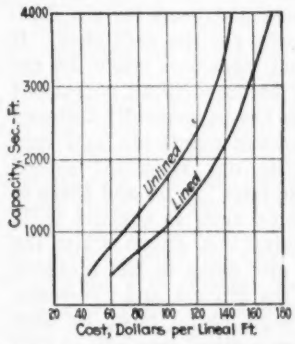


FIG. 2. COST OF LINED AND UNLINED TUNNELS IN HARD GRANITE

As soon as these two operations are completed, the bench is drilled from cross-bars with sufficient horizontal holes to insure the breaking to grade of the entire section drilled, and particular care should be taken in the location of these holes, as a high bottom delays the shovel progress materially. The drilling of the bench holes and the loading and shooting of the heading occupy from 8 to 16 hours, depending upon the difficulties encountered in "pulling" the cut shots. In hard rock, especially granites and trap rocks, it is necessary to shoot the cut shots at least twice, as it is essential that the cut holes be broken to the bottom of the holes, as the length of the round broken out depends upon this factor almost entirely.

The most successful shooting in large hard-rock tunnels is accomplished with what is called the double V-cut, which is made by drilling four vertical rows of holes at such an angle with the face that the two center rows meet on the vertical center line of the tunnel, and the two outer rows divide the distance between the nearest holes drilled parallel with the tunnel and the converging center rows.

The cut holes in solid granite are usually loaded with 60 per cent gelatin powder and are shot simultaneously by 440-volt alternating current and electric detonators before the side and bench holes are shot. Delay exploders are used for the later holes, and holes on opposite sides of the cuts in pairs are shot at the same instant, in order to prevent the scattering of the muck. It is very important that the numbers attached to the delay exploders properly represent their relative time of firing, as the explosion of the charges at the proper time is the

most important factor in insuring a good clean-breaking round and preventing the scattering of the rock far back from the face. The electric detonators are connected in parallel to two copper wires (usually No. 8) forming a bus strung up in front of the face. Particular care must be taken to see that all wires have good contacts and to see that the two wires leading from each detonator are connected to separate bus wires; to assist in this, two different-colored wires should be provided with all detonators.

The shooting line should be a separate line used for no other purpose and should be kept on the opposite side of the tunnel from all other electrical circuits. Before the bus wires are connected to it the shift boss should personally inspect all connections to see that everything is right. In this way, errors made in connecting the wires, due to haste, are often discovered and a poor shot is avoided.

Straight-Face Method.—With the straight face method, the entire heading is drilled after the mucking of the previous round has been completed, the drills being mounted upon cross-bars or columns which are often carried by a drill carriage. The drill carriage consists of a flat-car with working platforms for the drillers and chucktenders and racks for the drill steel. It also supports the columns and cross-bars while the car is moved up to the heading before drilling operations are begun. The drill carriage has permanently fastened to it all air and water pipes and manifolds, and very little time is required for setting up. With this method the drillers have no "mucking back" to do and there is no interference by the mucking crew to contend with. On the other hand no mucking can go on while the drilling is being done, and any delay in the mucking delays the commencement of the drilling, and vice-versa.

With the drill carriage, each round must be shot almost perfectly and a uniform vertical face left, so that the columns and cross-bars mounted upon the car can be placed within a reasonable distance of heading at all times. With this method, the double V-cut extending from top to bottom of the tunnel is used to the best advantage.

It is necessary to clean up practically all the muck in the bottom of the tunnel before the carriage can be moved into place, and no corners can be left in the face. As a result, before almost every mucking operation is completed, it is necessary to shoot one or two "boot" holes, with consequent delay. On the average, this method requires six hours more per round than the heading-and-bench method, and the saving in drilling costs is overbalanced by the additional mucking costs.

Pioneer-Heading Method.—With the pioneer-heading method, a small tunnel, large enough to permit the use of mucking machines, is driven ahead of the full-size heading, usually with its bottom grade coinciding with the bottom grade of the tunnel, and in a second operation the remainder of the tunnel section is drilled, shot and removed by steam shovels. All of the holes required for blasting out the full section can be drilled radially from the pioneer, and thus only a short time is required to remove the great mass of muck shot down from the radial holes. However, with this method the progress of the pioneer is very little faster than the progress which can be made by the heading-and-bench method when removing the entire section at one operation. Moreover, the cost of the pioneer bore is so great that the ultimate cost of the large tunnel is much greater than when the heading-and-bench method is used.

Costs and Comparisons.—In the adjoining Table I, which shows the relative costs of the various items (including all overhead) making up the tunnel costs on the Kerckhoff development, it will be noted that drilling and mucking make up more than 60 per cent of the total tunnel cost.

The cost of drilling per lineal foot of tunnel is less with long rounds than with short rounds. This is because the cost of drilling per lineal foot of heading

TABLE I—DIVISION OF TUNNEL COSTS ON KERCKHOFF DEVELOPMENT

Item	Percentage of Cost
Drilling, including depreciation on drills, drill steel, sharpeners, oil furnace, cost of sharpening steel, etc.	29.33
Powder, caps and fuse	10.00
Mucking, including depreciation on shovels, cars, etc.	33.66
Shooting, labor only	4.00
Drainage	0.67
Track work, labor only	2.00
Light and power	4.00
Ventilation, including depreciation on blowers and blower pipe	3.00
Depreciation on rails, ties, etc.	5.00
Depreciation on electrical equipment including wiring, electric locomotives, motor-generator sets, etc.	7.67
Clerks, etc.	0.67

TABLE II—SIZES AND METHODS ON SOME WESTERN

	Location No. of Project	Company and Contractor	Length, Ft.	No. of Headings	Cross Section, Size in Ft.	Date of Completion	Kinds of Rock	Timbering
1.	Skagit Project (Newhalem Tunnel)	City of Seattle (Day labor)	2,675	Two	6x7	Aug., 1921	Hard granite	None
2.	Skagit Project (Gorge Cr. Tunnel)	City of Seattle (R. C. Storrie & Co.)	10,978	Two	Horseshoe, 21 wide	Started Dec., 1921	Granite	
3.	Bridge River Project	Bridge River Power Co.	Two, 12,800 each		Horseshoe 136 sq.ft. each 12½x14	Started July, 1920		
4.	Pit River Project Pit Rv. No. 1	Pac. Gas & El. Co. (F. Rolandi)	10,111	Three	14 dia. circular (1,800 sec.-ft.)	Jan., 1922	Basaltic lava	25% length
5.	Don Pedro Dam	Turlock and Modesto Irrig. Dists.	600	Two	24x24	July, 1922		
6.	San Pablo Dam to Oakland	East Bay Water Co. (Bates & Borland)	14,553	Four	Horseshoe 5½x6½ inside lining	Early in 1920	Serpentine, sandstone schist, shale	70% length
7.	Caribou Project (Feather River)	Great Western Power Co. (Stone and Webster)	21,900	Nine	12-ft. circular	July, 1921	Slate varying greatly in hardness	All timbered
8.	Hetch Hetchy	City of San Fran (Const. Co. of N. Amer.)	18 miles	Ten	Horseshoe, 9x9 10-3—106 sq.ft. 13-4—153 sq.ft.	Mar., 1923	Slates, quartzite, granodiorite	Infrequently
9.	Big Creek Tunnel 8	So. Cal. Edison Co.	About 5,800	Four	20x20	June, 1921	Gray granite	None
10.	Big Creek No. 3	So. Cal. Edison Co.	30,000	Eight	21x21	About April, 1923	Gray granite	None
11.	Kaiser Crest (Hunting on Lake)	So. Cal. Edison Co.	13 6 mi.	Six	15x15	About Mar., 1926	Hard gray granite	None
12.	Shaver Lake Tunnel	So. Cal. Edison Co.	15,000	Four	8x11	May, 1921	Hard gray granite	None
13.	Kern River No. 3	So. Cal. Edison Co.	60,000	About Forty	8½x9½ 600 sec-ft.	Jan., 1920	Shale and decomposed granite to hard granite	About 15%
14.	Kerckhoff Tunnels	San Joaquin Lt. & Power Corp.	18,000		17x17	May, 1920	Seamless blue granite	None
15.	Kern Canyon	San Joaquin Lt. & Power Corp.	8,361	Ten	13½x14 unlined 8½x10½ lined	July, 1921	Gray granite broken formation	50%

depends upon two factors; namely, (1) the cost of setting up and tearing down cross-bars and columns, drills and air hose, and (2) the cost of drilling per foot of hole.

It is obvious that the first item is dependent upon the number of set-ups required in the total length of tunnel. The cost of drilling per foot of hole is slightly greater with long holes than with short holes, but the total length of holes drilled in short rounds per unit length of tunnel is considerably less with long rounds than with short, on account of the fact that each round does not break to the bottom of the hole.

The cost per yard of mucking with air-driven steam shovels depends almost entirely upon the quantity of muck to be removed per round. Nearly one-half of the cost of handling muck with steam shovels is the cost of

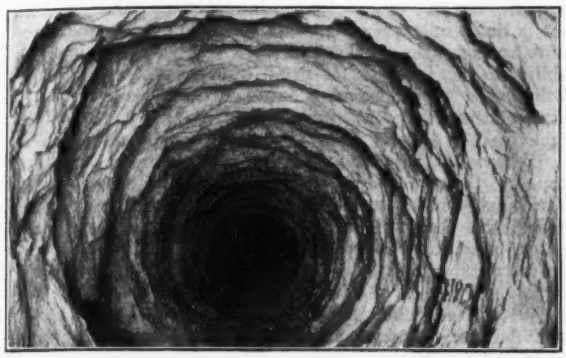


FIG. 5. TYPICAL CIRCULAR TUNNEL; DIAMETER 12 FT.

moving the shovel to and from its work and mucking up the scattered muck on the tracks after a shot so as to get the shovel up to the main body of muck. This cost is entirely independent of the total amount of muck to be handled at each round.

Advantage of Long Rounds.—It therefore follows that great economy can be obtained by lengthening rounds in large tunnels, especially where the cost of powder used in the cut shots is not excessive with long rounds. This statement is borne out by the fact that in large tunnels the most economical set-up can be made on the basis of one round per day, with all crews having regular hours. It is impossible to complete two rounds a day, and attempts to increase progress to more than one round per day can only be made by using swing shifts, which are admitted to be very unsatisfactory.

The practical average depth per round is approximately 80 per cent of the tunnel width. On the Kerckhoff tunnels, 18 x 18 ft. in blue granite, the economical average depth was found to be 15 ft. The cost of driving large tunnels per cubic yard decreases quite rapidly for sections larger than 16 ft. in width, as larger cars and larger dippers can be used.

Drills having power to drill deep holes with great rapidity must be provided, so that the drilling will not delay the tunnel progress, to get the greatest speed with greatest economy. The selection of drill steel is likewise of greater importance as tunnels increase in size, on account of the tremendous strain on the long steel and its tendency to crystallize under such conditions. Up to the present time the manufacture of special drill steel for this kind of work has not been attempted in this country, but now that such a large mileage of power tunnels is definitely scheduled for construction in the next few years, drill-steel manufacturers should immediately take steps to make better steel, if foreign steels are to be kept out of the local markets.

Importance of Speed.—On most hydro-electric power developments the length of time required to drive the tunnels is the factor which puts the minimum limit on the construction period of the entire development. This has been true on the Big Bend, Big Creek, Kerckhoff, Kern Canyon, Caribou, Hetch Hetchy, and many other developments. Water power developments are nearly always made at times when load demands require additional power resources. A 50,000-hp. development at the present time in California costs approximately $7,500,000; with interest at 8 per cent this represents a charge of $600,000 per year, or $1,640 per day. Every thirty days by which the construction period can be reduced on such a project therefore represents a saving in investment alone of $50,000 or $1 per horsepower. Often such a hydro-electric development is built to replace steam power generated by oil, which costs approximately 1c. per kilowatt-hour for oil alone. In such a case there is an additional saving in cost of oil amounting to $216,000 per month, or $7,200 per day, based on an 80 per cent load factor. It is in consequence of these conditions that progressive engineers are continually studying new methods in tunnel construction.

ROCK TUNNELS UNDER WAY IN 1920 AND 1921

	Methods of— Working Headings	Mucking	Depth Of Holes, Ft.	No. of Shots Per Round	Maximum Progress (One Heading), Ft. Per Mo.	Remarks
1.						No lining; lower end of tunnel under head of 266-ft.
2.						Conc. lining throughout (contr. $2,203,865)
4.	Heading & Bench	Hand mucking Stge Bat. Locos.	Heading— 8 to 10 Bench—16 to 22	Heading—16 to 22 Bench—5 to 7 ft.	524 ft. in month of July	Conc. lined throughout.
6.	Full Face	Hand mucking	6—8	7—10		
7.	Full Face	Hand & 1 shuveloder	6—8	6—10	597	Excessive water flow
8.	Full Face throughout	Several makes motor and air driven mucking machines	8—12 small 8—14 large	25—35 small 30—50 large	758 at Priest Portal	620 Sec. ft. Large section unlined— Small section conc. lined
9.	Pioneer Bore & Full Face	Steam shovels	6—12	40—50	After 8x9 pioneer 1,260	
10.	Heading & Bench	Steam Shovels			(Started Nov. 1, 1921)	
11.	Heading & Bench	Steam Shovels and shuveloders	About 10 to 18	50—60	(Shovels started. Oct. 15, 1921)	No lining
12.	Full Face	Shuveloders	About 8	20—40	526	
13.	Full Face	Hand mucking	8—12	15—35	470	Concrete lining throughout
14.	Handing & Bench and Full Face	Steam shovels (Marion 40)		Maximum of 80	451 (April)	No lining. Labor and powder $43 per ft.
15.	Enlarging old tunnel used as center heading	Shuveloder	12	12		

Land Drainage Developments in a Canadian Province

Large Field for Drainage—Double Levees To Hold Floods—New Drainage Board—Government Control of Maintenance

DITCH maintenance as a government responsibility, extension of land drainage to promote agricultural development, revision of the present law and appointment of a permanent board to administer the law free of political considerations, are high points of recommendations in the recent report of the Manitoba Drainage Commission, appointed to consider the present conditions and needed improvements. John G. Sullivan, consulting engineer, Winnipeg, is chairman of the commission, with H. Grills and J. A. Thompson as the other members. An abstract of this report is given below:

With 2,000,000 acres in organized drainage districts, less than $4,000,000 of bonds have been issued against these lands. Half of this area is under cultivation and with effective drainage more than 90 per cent could be put under cultivation. Drained lands in general are superior to lands that do not require drainage. Development of farming in this province depends largely on irrigation in the southwest and drainage in the north and east. The opportunities and cost of irrigation are such as to afford little encouragement. But possibilities of drainage are almost unlimited and future agricultural development depends largely upon how the matter is handled at the present time.

The people in the drainage districts have suffered more from inefficient drainage than from excessive or inequitable taxation, in spite of the fact that about 600,000 acres have paid drainage taxes for which they received little benefit. The major causes of this latter condition have been defective laws and the lack of any central controlling body free to execute and administer the provisions of these laws. Distribution and assessment of drainage taxes is an entirely different problem from the assessment of revenue taxes. The latter are based on valuation and power to pay. The former are based on benefits received and relief from liability of damage, as well as on the ability to pay. This responsibility for tax distribution should not be placed upon any officer of a department, as at present, or upon a government officer whose position is dependent upon the popular vote.

Among the vital defects of the present act is that it is susceptible of different interpretations, owing partly to the lack of proper classification of clauses relating to construction and to maintenance. Under existing conditions, the lands within a district are liable for the cost of all drainage work, just as much as if the district had a corporate existence. Although taxation in proportion to benefits is contemplated by the law, the method prescribed for applying this principle is not practicable. It actually places all responsibility on the government engineer, who should not be asked to assume such responsibility.

Drainage Board—A permanent drainage board should be appointed in order to relieve the chief engineer of the responsibility noted above, to protect the taxpayers in the formation of new districts and to insure efficient administration of the law. Its principal duties would be to levy drainage taxes, to approve of work to be done (both construction and maintenance) and to approve plans for such work. The carrying out of the work should be in the hands of the Department of Public Works, as at present, since an increase in executive organizations is not desirable. The expense of maintaining the board should be charged in equal proportions to the drainage districts and the general expenses of the province.

Drainage Districts—No new districts should be formed where the development and demand for land will not fully warrant the expenditure. The boundaries of any district should be extended to include all lands whose surplus waters drain into that district and are carried by any artificial channel through it to a natural outlet. This is a natural division of lands; any other division leads to disputes. But it is not contemplated that all lands within the new boundaries would be taxed.

A plan of forming new districts on the basis of individual watersheds or drainage areas, thus breaking up some of the older districts, has many good points. But the difficulty of allotting to each watershed its proper portion of the existing debts, together with the resulting dissatisfaction, outweighs the beneficial features.

Distribution of Taxes—Lands should be classified according to wetness. Lands worthless without drainage would be in the highest class. In the lowest class would be land that is liable only because water from it damages the lower lands or increases the cost of protecting them. Since the "ability to pay" is a factor in all taxation levies the ability of the lands to produce must be taken into account.

In justification of the principle of taxing lands on the higher levels, it may be said that if people on the high lands have the right to do as they please on their own property, the same should be true of those people within a drainage district, who would thus have a right to dam against the waters from the higher lands. Several road and drainage ditches are now discharging water into drainage districts, which is unjust. If the people whose lands are drained by these ditches should be compelled to provide an artificial channel to carry off their waters, the cost might be many times that of an equitable tax for the use of the district ditches.

The government should pay taxes on benefited land owned by the Province. Municipalities should pay an amount equal to the benefits derived from highways built in connection with ditch construction.

Some of the ditches need to be enlarged since they drain more land than was contemplated. New capital should be raised for this work, collecting the money finally by taxing the lands liable for the excess water as well as the lands benefited.

Ditch Maintenance—This work consists of clearing out material which may slide or be blown in, or may be deposited by the water. It includes also the cutting of weeds and underbrush, the care of levees, and the repair and renewal of culverts and bridges. In some of the older districts this has been neglected so long that it would be almost impossible for the municipalities to do all this deferred work. Instead of this maintenance being in the hands of the officers of the various municipalities, it should be assumed by the government, as agent for the drainage districts. A substantial tax to cover the expense should be levied on the lands in the same proportion and manner as the tax for capital account.

An exception to this is that the government cannot accept responsibility for the removal of snow and ice from any ditch or stream. Such work must be attended to by local authorities. Consideration should be given to the economy of windbreaks along ditches in light soil, to prevent the soil from being blown in. When the annual cost of clearing the ditch is greater than the interest on the cost of an efficient wind break, including the land required, the government should have power to order the construction of such works.

In certain districts the main dredged channels should be double-diked, a levee being built 250 to 300 ft. from the spoil bank to confine the flood waters. During the spring break up the channels, when full of snow and ice, will not carry off the waters that come from the higher lands. These levees would also be a protection against extraordinary floods during the summer.

Building Roads on Gumbo Fills in the Arkansas Bottoms

Constructing 100 Miles of Surfaced Road in Two Years—District Co-operation Expedites Progress—Territory Previously Without Highways

By Charles T. Fisher
Engineer in Charge for the Morgan Engineering Co., Memphis, Tenn.

CONTRACTS of unusual form and a number of structural details and construction methods designed to meet the conditions of road building in the Mississippi bottom lands, make the road building of 1920-21 in Crittenden County, Arkansas, a matter of interesting record. Practically all of the road had to be put on embankment to keep it out of the water. Precast concrete culverts were employed as much as possible to reduce hauling over the gumbo fills made from side ditches. With several districts combining to purchase gravel, spur tracks, local stockpiling and district-owned railway equipment were practicable and economical. Contracts for graveling were devised which avoided the disadvantages of the "ton-zone" form. A new "silica" surfacing was employed successfully, instead of gravel, on a large mileage.

Engineers in private practice build the roads of Arkansas.

The state highway department engineers have little control except when Federal aid is involved.

There are no county engineers or city engineers or public works departments.

Every public work—road, sewer, bridge, etc.—is constructed by an "Improvement District," created, under the law, for this specific purpose.

The engineers are appointed by the commissioners of the district; their fee, established by law, is 5 per cent of the cost of the improvement.

Some three or four hundred improvement districts, each with its engineer, are constructing the improved road system of Arkansas.

The work outlined in the accompanying article is an example of highway development under the system indicated.—Editor.

In 1919 six road improvement districts were organized in which the entire area of nearly 600 square miles of Crittenden County, Arkansas, was included. The two most important districts were 7 and 9, Fig. 1, which conducted their roadwork together under the supervision of the Morgan Engineering Co., Memphis, Tenn. Approximately 16 miles of earth roads, 66 miles of gravel roads and 14 miles of concrete roads have been completed in the two districts in 1920-21. The work has been road building rather than road improvement, for in most cases there was not even a trail on the location of the new road.

Roads Built on Fills.—The finished road grade was fixed at not less than 1.5 ft. above the general surface of the ground, and not less than 2 ft. above local high water. This rule made the yardage of embankment high, averaging about 11,000 cu.yd. to the mile. It was necessary, however, because of the difficulty of obtaining perfect drainage in the flat lands and because of the marked capillary action of the soil. Practically none of the road system is in cut. The embankments were built 24 ft. wide at the top, with 1.5 to 1 side slopes. They were formed from side borrow pits which were dug to grade and carefully drained.

Dragline machines, elevating graders, wheeled scrapers and blade graders were all used in building the fills, but by far the greater part of the dirt was handled with fresno scrapers and mules, a combination which gave the most satisfactory results under the conditions. Negro labor was used on all parts of the work. In both districts there were 1,050,000 cu.yd. of embankment. There were also numerous brakes of cypress and gum to be crossed, and clearing and grubbing, Fig. 3, amounted to 278 acres.

Precast Culverts Reduce Hauling.—It was difficult and expensive to haul over the unfinished roads, Figs. 2 and 4. The alluvial soil, when dry was rough and rutted, and when wet, was a mire. Materials for culverts and bridges cost much time and trouble to get onto the ground. However, a considerable saving was effected by the use of precast concrete culverts, where only small openings were required. These were made in 2-ft. lengths, having a horseshoe section which was well reinforced, and were set in a reinforced concrete base, which was poured in place. About 9,200 lin.ft. of culvert between 12 and 36 in. in diameter were used. Box culverts, which were comparatively few, were built of reinforced concrete according to the standards of the Arkansas State Highway Department. There were 25 bridges of concrete or plate-girder construction, and 1,850 lin.ft. of trestle.

Joint-District Gravel Supply.—Preparations for surfacing were commenced as soon as the grading contracts were let. No local materials were obtainable. Districts 7, 8 and 9 of Crittenden County, and the Ozark Trail District, of Poinsett County, therefore, united as the Crittenden-Ozark Joint-Project to import surfacing material. Under this arrangement 17 spur tracks, each about 20-car capacity, were built for unloading materials, and 10 cranes were purchased, with the intention of stockpiling sand, stone and gravel as rapidly as possible. The freight in Districts 7 and 9 alone amounted to over $338,000.

Stockpiling was well under way when the federal embargo issued in June, 1920, shut off the supply of open-top cars. For a time it seemed that it would be necessary to suspend operations entirely. Surfacing with gravel had, however, already been commenced, and the commissioners, determined that the work should not be stopped, purchased 105 20-cu.yd. standard gage air-dump cars which had been built for the government during the war. Arrangements were made with the St. Louis & San Francisco Ry. to operate these cars between a gravel pit near Wittenberg, Mo., and points on its line in Crittenden County, an average distance

of 170 miles. With this equipment gravel was hauled in solid trains of 35 cars, a train making a round trip in three days so that a train-load of 700 cu.yd. could be delivered each day.

In building up a stockpile with dump-cars, the spur was first raised to the desired height by jacking up the track and working underneath it the gravel dumped from the cars. The pile was then widened by throwing the track over on the fresh material after each train-load was deposited. From 12 to 14 laborers were required for the work. Contracts for unloading dump-cars, which included shifting and maintaining the stockpile tracks, were let at prices much lower than the cost of unloading by crane. Eight piles of gravel and two of stone were built up in this manner. About

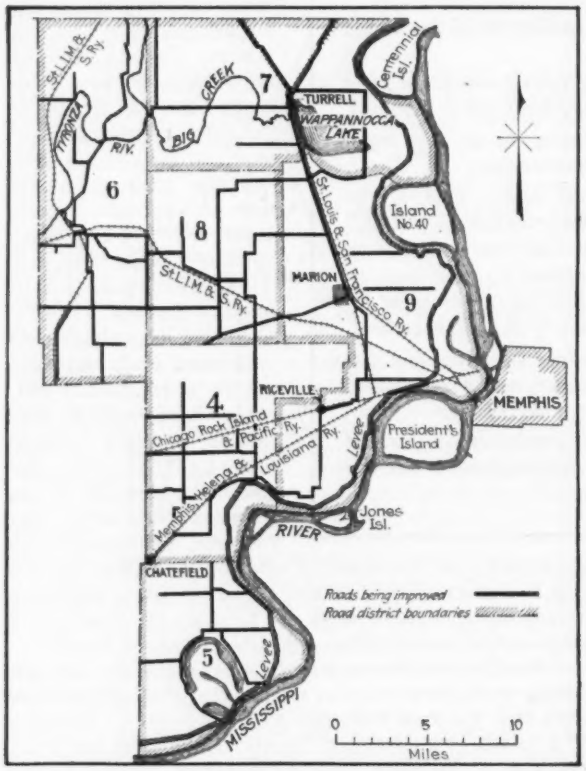


FIG. 1. NEW ROAD SYSTEM, CRITTENDEN COUNTY, ARK.

190,000 tons of road material were handled in the dump-cars, which were sold by the road districts soon after the shipments of material were completed.

New Form of Graveling Contract.—A general contract for gravel hauling and surfacing was entered into early in 1920, under which the districts rented 36 3½-ton trucks, purchased other necessary equipment and paid for all labor and supervision. Four ten-ton rollers, eight tractors, a number of blade graders and the small tools required were purchased at this time. A few miles of gravel road were completed during the season, but the arrangement proved unsatisfactory and was discontinued in the fall. District 8 withdrew from the joint project in November. Work in Districts 7 and 9 was continued, and contracts covering the gravel surfacing were let in November, 1920, and in May or June, 1921.

The form of contract differed somewhat from that in

FIG. 2. GRADE RUTTED WHEN DRY

common use in gravel road work in the delta states. Ordinarily the work is divided into one-mile "zones," beginning at the railway siding or gravel pit. A price per ton is paid for gravel incorporated in the finished road within the limits of the first zone, and an additional price per ton for each succeeding zone beyond the first. This system has serious disadvantages. Unless the loads are actually weighed, the tonnage of gravel hauled from a pit or stockpile into any particular zone can only be guessed at. So much of the inspector's attention is needed in trying to keep track of the number and size of the loads hauled and the zones in which they are placed that he has no time left to see that the surfacing is properly constructed. Consequently he spends his days counting wagons and his nights arguing with the contractor's superintendent over the count, and the hauling comes to be regarded as the important part of the job, with the construction of a smooth and durable surface a secondary matter.

As a compromise between the "ton-zone" and "cubic yards in place complete" method of payment, the surfacing contracts let in 1921 contained two pay items, "gravel hauling" at a price per cubic-yard-mile, which included the hauling and nothing more, and "gravel surfacing," at a price per cubic yard, which included loading the gravel, preparing the sub-grade, gravel manipulation and building and trimming shoulders, in short, everything except the haul. Estimates and payments for the hauling item were based on average haul and cubic yards measured in place on the road. The

FIG. 3. WAY CLEARED THROUGH CYPRESS BRAKE

FIG. 4. GRADE MUDDY WHEN WET

gravel was measured before rolling, the spreading being gaged with blocks and with dump-boards set at the edges of the trench—like forms for concrete pavement. This scheme of paying for the work left the inspector free to supervise the construction of the surface, and proved satisfactory to both contractors and engineers.

Gravel was furnished by the districts, stockpiles being located at ten unloading points. The arrangement of contracts was such that all the material in each stockpile was used by a single contractor.

Gravel Surface Construction.—In constructing gravel surfaces, the finished embankment was trenched to a depth sufficient to provide earth for the shoulders and the gravel was spread in two courses, starting at the point most distant from the stockpile. Heavy caterpillar tractors, scarifiers and blade graders were generally employed for cutting the trench, though in lighter soils teams were sometimes used. A few trucks were used for hauling gravel, but because of soil conditions most of the hauling was done with teams. At the stockpiles the wagons were loaded both by cranes and by hand labor. The spreading was done by blade graders, using as much hand labor as might be necessary to get a uniform surface. Ten-ton rollers were used for compacting the surface.

On the main roads the surface is 16 ft. wide, and was built in two courses each 6 in. thick, before rolling. On the lateral roads the surface is 14 ft. wide and a 6-in. bottom course and a 4-in. top course were used.

Silica Surface Roads.—On 13 miles of road, a gravel composed of fairly hard pebbles, but containing a large amount of red clay, was used. Until thoroughly compacted this material ruts easily in wet weather, but it eventually forms a very durable surface. On the remaining 53 miles of gravel road a material known as "Silica" obtained from a pit near Wittenberg, Mo., was used. Silica can hardly be classed as a gravel, though it contains varying percentages of a flinty stone similar to novaculite. The binding material is a fine yellowish substance which has the property of becoming very hard if compacted when moist.

In building the silica roads each load was saturated with water at the stockpile, and was spread and rolled while still very damp. If properly manipulated, a hard and compact surface resulted, which compared favorably with the best waterbound macadam. Rolling dry silica was found to be a waste of labor. The silica surfaces have worn evenly under traffic, without the formation of ruts and potholes. Prolonged dry weather will doubtless cause more rapid wear, and a surface treatment to retain moisture will be necessary. Because of the large proportion of fine material present, treatment with bituminous material is unsuccessful. A mile of excellent silica road was ruined by an oiling experiment. No penetration could be obtained, and the "picking up" of the oiled surface produced a rough road in a few days' time.

FIG. 5. PRECAST CONCRETE CULVERTS

FIG. 6. BROOMING CONCRETE PAVEMENT

The construction of concrete road followed usual methods and there was nothing unusual in equipment or results. For the Morgan Engineering Co., Charles T. Fisher was in general charge of the work, with J. S. Sager, J. E. Fontaine and E. W. Earlę as principal assistants.

Suspension Bridge Belt Conveyor

A belt conveyor 500 ft. between centers and supported by a suspension bridge has been constructed to convey coal from the headhouse of the Guyan Mining Co. in Logan County, Virginia, to the tipple house located on the opposite bank of the Guyandotte River. The bridge consists of two 2¼-in. steel cables 204 ft. in span, with ⅝-in. suspender rods every 5 ft. which support 4 x 6-in. cross-timbers. On the platform is erected a housing for the conveyor and for a footway. The conveyor is 30 in. wide. The plant was installed by the Stephens-Adamson Mfg. Co., of Aurora, Ill.

Can The Railway Engineer Become An Operating Officer?

Opinions of Opportunities, Qualifications and Results—Promotions from Different Branches of Service

HAS the railway engineer much opportunity for entering the operating department? Is he considered in appointments to that department? Does he make a successful operating officer? These questions have been put to a number of representative railway men. The replies indicate that in general there is no particular encouragement or inducement offered, but that an aggressive man can break through. Although engineering training is an assistance in the new work, personality and a special aptitude for operating service are much larger factors in the success of the engineer who desires or elects to become an operating officer. One reason why these opportunities are limited seems to lie in the fact that relatively few of the higher operating officers appreciate the advantages which technical training give to the man who has the other necessary qualification. Speaking generally, therefore, it may be suggested that the railway service might benefit materially if greater opportunities were open to the engineer who has a predilection for the operating department.

Opportunities for Engineers.—Some of the replies to these questions indicate that engineers are given some consideration when appointments to the operating department are made. They appear to make it plain, however, that as a general thing the engineer must not only possess the qualifications, but must take the initiative and be an aggressive applicant if he desires to enter operating service. There are, of course, men in the engineering department, as in other departments, who have special aptitude for operating service, but even for them the transfer or promotion is not easy to secure. Four or five replies refer specifically to certain high operating positions held by former engineers, but reading between the lines it would appear that in most cases these men had exceptional capacity or determination, but still have to make their own opportunities for entering the desired department and attaining the desired position.

It is pointed out, also, that the number of men available for appointment is small as compared with the number of men available in other branches of service, For instance, where the engineering department has 20 men available for consideration, there are likely to be 200 men available among the train dispatchers, clerks, master mechanics and trainmen.

It is evident from the replies that much more depends upon the man himself than upon the fact of his technical training or knowledge. One officer, himself a former engineer, states with regret that because of their education, their line of work and their line of thought, engineers as a rule are not qualified to take up the more complex duties of the operating department.

Ability to handle men is an essential which assumes large proportions under present conditions.

In one reply it is stated that it is natural to select as trainmaster a chief dispatcher, a road foreman of engines or a superintendent's chief clerk, since the duties are essentially transportation duties and these men are more familiar with the details of transportation work than are engineers or roadmasters. Similarly, it is considered appropriate to promote a trainmaster to the position of superintendent. For this reason, the relative lack of consideration given to the engineer is due to natural selection rather than to discrimination.

Engineers in Operating.—In answer to the general question as to whether many engineers do actually enter operating service, most of the replies are in the negative. Individual examples are given of engineers who have become identified with the operating department, but these seem rather an exception to prove the rule. Some of the writers state that few engineers show any desire for such a change of departments. But in reply to this it seems fair to note the very slight inducement or encouragement offered. If an engineer has such a desire it is up to him to break into the operating department, since there is no open door before him.

That a course of experience in the operating department would broaden and benefit the men in the engineering department is the opinion of two chief engineers, one of whom regrets that so few engineers show an interest in this important part of railway service. This opinion is a little aside from the main subject, however, since it relates to men who would return to the engineering department instead of remaining permanently as operating officers. It is in line, however, with another suggestion that locating and construction engineers would be better fitted for their work if they should serve for a time on maintenance work, since they would then appreciate that there was something beyond an easy or cheap location and construction.

Engineers as Operating Officers.—Do engineers make good when called to serve as operating officers? Here the replies are largely in the affirmative, though qualified by the reference to the necessity for particular aptitude and ability. In other words, promotion to the operating department is given to engineers whose executive ability has been measured by individual fitness due not to experience in one branch, but to a broad view of the requirements of railway operation. One reply points out that there are undoubtedly good engineers who would not make a success in operating service.

That the technical training of the engineer who has the other necessary qualifications tends to make him a better operating officer than many men who came up from other departments, is the opinion expressed by several writers. One of these refers to engineers placed recently as assistants to high operating officers. This view is qualified in one case by the suggestion that the engineer must be taken while young and before he has become set in his ways. Another aspect of the situation is presented by one writer who considers that the extent to which engineers are given opportunities to work in the operating department depends to a great extent upon whether the higher operating officials have any material knowledge or experience of engineers and engineering.

There appears good reason to suggest greater regard for the engineering department as a source of good operating officers, and greater opportunity for the young engineer who desires to transfer his activities to the operating department.

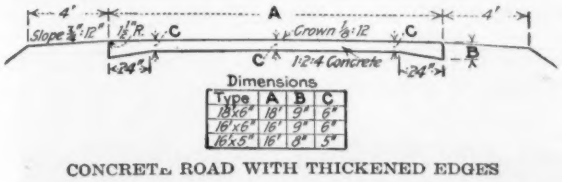
Pavement with Thickened Edges Takes Heavy Loads

New Concrete Road Section Adopted by Maricopa County, Arizona, Carries Very Heavy Traffic with Slight Damage

By C. L. Jenken
Construction Engineer,
Maricopa County Highway Commission, Phœnix, Ariz.

SUCCESSFUL service has been given by the new design of slab used for the 130 miles of concrete roads, recently completed, under the first contract, of the 309-mile hard-surfaced road system planned by Maricopa County, Arizona. All roads, some of which were laid on swelling soils, are in good condition, and 3½ miles, now over 15 months old, subjected at a very early age to the travel of material trucks, do not show indications of failure. Methods of construction were described in *Engineering News-Record* May 26 and June 16, 1921, pp. 882 and 1026.

As shown by the accompanying drawing the slab is a modified, inverted-curb section designed to strengthen the edge and at the same time permit simple construc-



CONCRETE ROAD WITH THICKENED EDGES

tion of the sub-grade. The thickened edges add structural strength as the area of load distribution and sub-grade resistance decreases, thereby securing a paving slab with a more uniform resisting strength. It is also considered that the section forms better drainage between the slab and the sub-grade, maintaining a more uniform moisture content and a more uniform contact. Due to its inverted cup-like shape it is believed that it also retards swelling or squeezing out from under the pavement edges.

The section permits the use of simple methods in preparing the subgrade. The ordinary subgrade cutting machine can be used with only slight adjustments of the cutting blades and, prior to the final trimming, the entire width can be rolled with the common macadam type roller.

No indication of failure is apparent on the 130 miles of completed pavement. No crow-foot cracks at expansion joints or at transverse cracks have been noted. Longitudinal cracks are very rare and the few observed are at expansion joints and only a few feet in length; none is of a serious nature. Transverse cracks or temperature cracks average less than 50 to the mile and not more than eleven have been found in any 500-ft. section.

A section 18 ft. wide having a 6-in. center and 9-in. edges, 3½ mi. long, was one of the first laid and now is over 15 months old. It was laid on a heavy soil, considered to be one of the poorest, where no rock fill or sand cushion was used. Before the last mile of road was four weeks old it was subjected to the travel of materials trucks, which were heavy five-ton trucks equipped with batch-compartment dump bodies and loaded with four batches, which consisted of 16 cu.ft. of rock and 8 cu.ft. of sand each. The trucks and material weighed approximately 23,400 lb. These trucks average a total of 70 round trips daily in 8 hours for about 280 days, traveling at a speed varying from 12 to 18 miles per hour. During this time two low places were completely submerged from a break in a canal bank for a period of six hours, and due to insufficient culverts on side roads this water stood for several days on both sides of the roadway and well up on the shoulders so as to thoroughly saturate them.

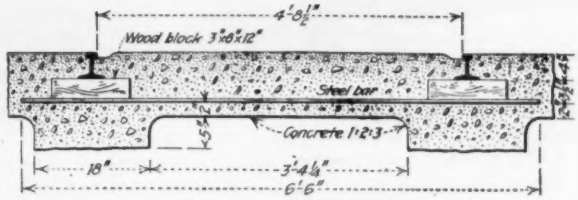
During this time the materials trucks kept to the extreme edge of the pavement practically for its entire length, in many cases the rear tires would extend over the edge of the pavement. A careful watch was kept during this heavy traffic, and later, an accurate survey of cracks was made and it was found that no visible wear or cracks could be attributed to the overloading, which is considered to be equal to several years of normal traffic.

Design of Street Railway Includes Tie Bars as Concrete Reinforcing

By Julian Montgomery
City Engineer, Wichita Falls, Tex.

IN THE accompanying sketch are shown details of a railway track recently laid through part of the business and residential section of Wichita Falls, Texas. The track was laid on a street paved for the most part with 6-in. two-course concrete reinforced in the bottom course with light hog wire. It was therefore necessary to remove a 7-ft. strip without injuring the pavement as a whole before the track could be laid.

As approved by the city the design for the track included the use of tee rails supported on combination steel-and-wood ties. Each tie has two asphalt-coated blocks to support the rails, the blocks being connected



STEEL TIES REINFORCE BETWEEN-RAIL PAVING

by pairs of light angles 8 in. apart, which form reinforcement for the 1:2:3 concrete paving. The ties are spaced 30 in. c. to c. A concrete beam is built under each rail and a 9½-in. concrete pavement between the rails.

After the contractor had shaped the subgrade the traction company laid the track to line and grade and welded the rail joints. As sections of track were completed concreting was undertaken. The surface was floated and troweled after first being dried with a liberal sprinkling of 1:1 dry sand-cement mixture. A thin wooden strip was tacked to the wood blocks of the ties to hold them in line. When concreting was begun a strip of prepared asphalt joint-filler was placed alongside this wood strip. The completed concrete was covered with 2 in. of dirt and kept wet for eighteen days. The dirt was then removed, but no traffic was allowed upon the track for an additional ten days.

The work was done under the direct supervision of Julian Montgomery, city engineer, with J. B. Upchurch, assistant in charge of paving. The contractor was I. H. Roberts, Wichita Falls, Tex.

Broad Problems Analyzed in Design of Winnipeg Bridge

Two-Span Concrete Structure Raises Interesting Economic, Æsthetic and Structural Questions—Elements of Design Carefully Proportioned To Insure Pleasing Appearance

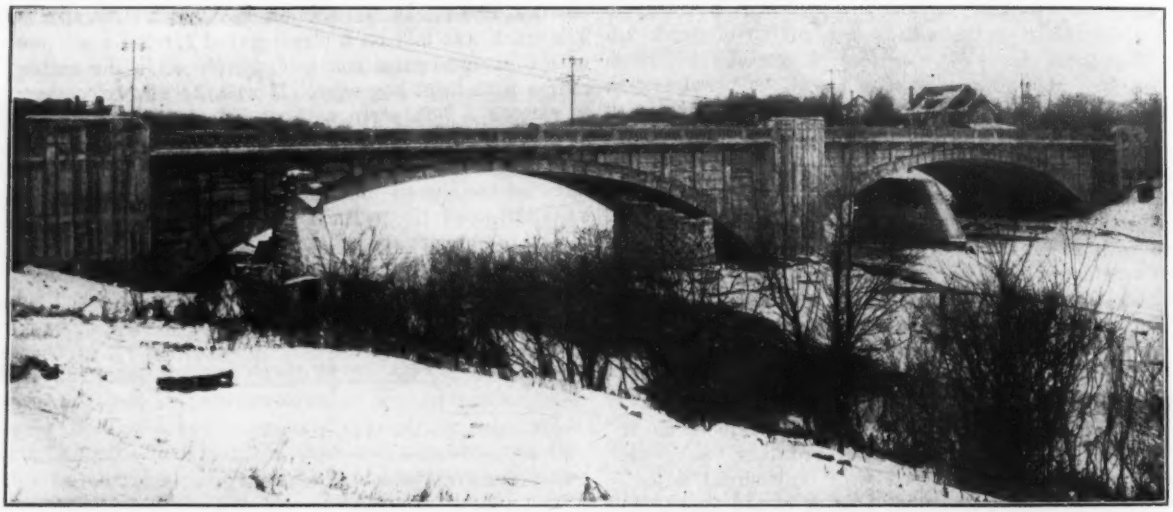
By J. F. Greene,
Consulting Engineer, Winnipeg, Man.

Abstract of paper read before the Winnipeg Branch of the Engineering Institute of Canada.

THE Maryland St. bridge is a reinforced-concrete arch structure provided to carry traffic across the Assiniboine River between the business section and the best residential section of the city of Winnipeg. The deck consists of a roadway 50 ft. wide and two sidewalks each 7 ft. wide, and provides for four lines of vehicular traffic including street cars, with a maximum grade of 2 per cent. While the structure, as an example of the standard barrel-arch type of concrete bridge is not an object of special interest, the proportioning of its parts to form a harmonious whole, and the mental processes involved in that proportioning may be of interest to men engaged in the solution of similar problems.

The determination of the number of spans was not left to the designers. While comparative estimates disclosed that a three span bridge would be slightly cheaper than one of two spans, and while æsthetic precedent demanded three spans rather than two, the Department of Public Works objected to the location of the south pier in the navigation channel and intimated that a two span bridge only would be acceptable. The elevation of the crown of the south span was fixed by the clearance set by the Government for navigation; so the curves for the arches were pre-determined closely enough to enable the making of preliminary sketches in order to work out the most effective treatment for the abutments, piers, spandrel walls and approaches.

Æsthetics of Concrete Design.—A slight digression into the architectural limitations of concrete as applied to bridges, may not be amiss. A concrete bridge presents all exposed faces of one color, a dull monotonous gray. These faces in turn, disclose various irregularities, due to the method of constructing concrete structures. Each lift, or day's run of concrete is distinctly outlined in any exposed concrete surface. Board marks differ in shade, some being of dark gray, and others lighter, due probably to the different absorptive capacities of the several boards. Any yielding of forms, however slight, produces offsets or waves, and occasionally rock pockets appear which must be covered by disappointing patches. All such appearances are irregularities, and are displeasing to the eye. It is incumbent upon the designer so to proportion the major members of the structure that it will be pleasing and dignified, while at the same time he accentuates the minor members by the use of pilasters, inserts, and grooves that will divert attention from the unavoidable defects of concrete surfaces.



GENERAL VIEW OF MARYLAND STREET BRIDGE

Here is seen the illusion of height produced by carrying the piers and abutments above he level of the handrail, by using vertical form boards and decorative lines and by imposing pilasters on the spandrel walls. This view illustrates also the pleasing effect obtained by breaking up the uniformity of the spandrel surfaces and arch rings.

Development of Æsthetic Features.—It has been assumed as axiomatic that the dimensions and proportions of the several parts should be indicative of the service that each part contributes to the stability of the whole. The abutments, marking clearly the river banks and the limits of the arch spans, should impress the observer as having sufficient mass to withstand successfully the horizontal thrust from the adjacent arch spans. The pier, although of sufficient mass to carry the vertical loads from the arches, should present faces so proportioned as to offer the least obstruction to the passage of water and ice.

With these limitations and axioms in mind, preliminary sketches were made. In one sketch an excessive use of horizontal lines, and in another an equally exces-

sive use of vertical lines, disclosed the proper basis of treatment for this structure. As outlined, the bridge appeared to be squatty, this quality being exaggerated by the excessive use of horizontal lines and relieved greatly by the appearance of vertical lines. Proceeding from the assumption that the structure lacked height, abutments and piers were increased in height to a level above that of the handrails; the surfaces were relieved with deep vertical grooves, and even the form boards were placed vertically to further the illusion of height. The spandrel wall surfaces were broken up by pilasters of which the relief was exaggerated by means of inserts at both edges to accentuate vertical shadow lines, thereby contributing further to the illusion of height.

To conceal the effects of yielding forms and the outlines of each days run, grooves were left in the concrete at regular intervals, both in the arches and in the walls. Each days run ended in a groove, which concealed the joint and, in addition, cast a shadow that tended to relieve the monotony of the large flat gray surfaces. In proportioning the exposed parts of the sidewalk slabs and brackets it was expedient to exceed the structural requirements of the design, lest the parts should appear too light for stability. By breaking the sloping under sides of the brackets into several vertical faces, an illusion of breadth and strength was produced and the impression that would have resulted from the monotonous succession of plain brackets gave way to one more definite and pleasing.

Treatment of Deck.—So much for the proportioning of those parts of the structure, which would be visible to observers standing either upstream or downstream. The treatment of the deck of the bridge presented a separate and a different problem. Smooth, easy approaches from connecting streets with the least possible grades were desirable. The elimination, or failing this, the subordination of all trolley and light poles on the deck of the bridge, was adopted as a policy to be followed consistently.

The design of the handrail, the outstanding portion of the structure visible from the deck, remains. Since the observer views the handrail, not from a distance, as he views the arches, piers, and abutments, but at close range, the appeal to the imagination lies not so much in the composition, the grouping of the parts into a well balanced whole, as in the excellence of the parts themselves, the intricacy of the fabric and the quality of the texture. It is essential, therefore, that special methods of handling the concrete be adopted in order to eliminate air-holes, water-holes, form marks and the other surface irregularities of commercial concrete. This may be accomplished in various ways, either by the dry process, by the use of sand molds, or by scrubbing the surface of green concrete with steel brushes thereby exposing a specially prepared colored aggregate. On the Maryland St. Bridge the third method was adopted, and the colored aggregate consisting of red granite, crushed to pass a ¾-in. screen, was exposed by scrubbing with steel brushes, and cleaned by several washings of muriatic acid and water.

The bridge is lighted by four-light clusters, set on combination light and trolley poles, standing in the center strip and located about 90 ft. apart. Each light is diffused by wide-angle refractors and the lights have been set high enough on the poles to obviate dangerous shadows from passing cars. So much for the principles and methods involved in the æsthetic phase of the design.

Design of Structural Elements.—The adoption of a solid barrel, earth filled arch, rather than an open spandrel reinforced-concrete deck bridge, rested primarily on economic grounds and secondarily on structural considerations. With an average fill of 10 ft., the earth-fill arch showed a saving of 25 per cent as against an open spandrel arch. On the approaches the saving was greater, since the increase in the cost of the deck was not offset by reduction in the substructure due to reduced dead-loads. Further, the earth-fill type, exposed only at the intrados, is less subject to movement and cracking caused by extreme temperature changes than is the open spandrel. The solid barrel type, in addition, offered greater mass and at the same time less obstruction to the passage of ice.

In the design of the approach retaining walls, a radical departure from standard practice was made in that the foundations were carried down through more than 20 ft. of excavation, and bonded into the rock. This exceptional treatment was brought about by the exceptional conditions at the site. Just east of the north end of the bridge, the Cornish baths had shown a strong tendency to move toward the river, and a few hundred feet west of the bridge, several apartment blocks had actually moved and tilted. One section of one of these blocks had been condemned and demolished. It was clearly evident that the bank was not stable and that structures resting on this bank would be equally unstable; so recourse was had to the unusual foundations here described.

Each arch was designed for a maximum live-load of four 50-ton cars with a 20 per cent impact allowance. The arches have been so proportioned that under all conditions of loading the line of resistance lies within the middle third, resulting in a maximum compression of 453 lb. per square inch. The maximum for combined live-load, dead-load, rib shortening, and a temperature drop of 40 deg. is 682 lb. per sq.in.; and for a temperature drop of 60 deg., the maximum combined stress is 750 lb. per square inch. To provide for tensile stresses due to rib shortening and temperature, steel reinforcement has been provided.

The bridge rests on solid rock foundations. The abutments were designed with the line of resistance within the middle third and with a maximum pressure on the rock of 9¼ tons per square foot. The rock was excavated to a depth of 6 ft. to provide additional resistance to sliding. The maximum bearing pressure from the pier on the rock is 11 tons.

The spandrel walls were designed as cantilevers resting on the arches, the moment from the sidewalk brackets being transmitted through counterforts to the arch rings. Expansion joints at the haunches provide for lateral movement resulting from the fall of the arches due to a drop in temperature, and at the third points expansion joints predetermine the cracks resulting from the rise of the arches due to a rise in temperature. All joints have been continued to the handrails and appear to be working satisfactorily. Those at the junctions of the handrails with the piers and abutments have opened approximately ¾ in. at this writing. All joints in the walls and sidewalks have been sealed by folded strips of sheet lead to prevent the escape of water through the joints with attendant discoloration of the concrete.

Proportioning of Concrete Mixtures.—The engineering department had been instructed to use the gravel and rock provided by the Greater Winnipeg Water District at a price of $3.85 per cu.yd. for gravel supplied during the winter, $3 per cu.yd. for gravel furnished during the summer, and $4 per cu.yd. for crushed rock. The problem, stated simply, was to determine the economical proportions of cement, sand, rock, and water, combined to form concrete, that would give an assured compressive stress of 2,250 lb. at 28 days, i.e., three times the maximum stress in the arches. Preliminary investigations disclosed the fact that there were wide variations in the physical characteristics of different samples of gravel from the same pit. Tests of the gravel showed that the weights per cubic foot varied from 98 to 115 lb., and that the coarse retained on a ¼ in. screen varied from 21 to 48 per cent. Two series of tests were carried out, each embracing the making and testing to destruction of 60 cylinders, each 6 in. in diameter and 12 in. long. In the first series, the lighter, coarser gravel, weighing approximately 100 lb. per cubic foot was used. The materials were combined in one group to make 1 part of cement to 6 parts of the aggregate such as 1:1½:4½, 1:2:4, 1:3:3, 1:3½:2½, and 1:4:2; and in another group to make 1 part of cement to 7½ parts of the aggregate, as; 1:2:5½, 1:2½:5, 1:3:4½, 1:3½:4.

In the second series similar proportions were used with a gravel that weighed approximately 114 lb. per cubic foot. While no mechanical slump test for consistency was employed, the amount of water used was the least consistent with proper workability. The quantity of water used in the first series varied from 6 to 8 per cent by weight of the cement and aggregate, and the water cement ratio from 0.58 to 0.86 by volume. For the second series, the quantity of water varied from 7 to 9 per cent, and the water cement ratio from 0.76 to 1.05.

Final Tests.—Compression tests at 28 days showed cylinders of the first series to be about 22 per cent stronger than those of the second although composed of the same proportions by volume. In order to assure satisfactory results under the most adverse conditions, it was assumed that when it came to work in the field the aggregate might be of the grading used in the second series showing the poorer results. Revising the proportioning to meet the contract specifications of 5 sacks of cement per yard for foundation concrete and 6 sacks per yard for superstructure concrete, and running confirming tests, revealed that the best results at the least expenditure were obtained with the proportions of one of cement, four of gravel, and two of rock for foundation concrete; and one of cement, three of gravel and two and one-half of crushed rock for superstructure concrete. Complete records of the properties of the ingredients and of the concrete, were filed.

In order to be sure that the concrete in the structure was of the quality anticipated as a result of the tests, sample cylinders made of the concrete actually placed, were taken daily and tested at 28 days. The concrete placed in the substructure, containing 5 sacks of cement per yard, was very dry and would just quake under tramping. The average of the tests run during the months of February, March and April for this class of concrete was 2,100 lb. per square inch at 28 days. The concrete in the approach walls, containing 6 sacks of cement per yard, was wetter than the foundation concrete, but with only enough water to permit of spading and consolidating the mass in the thin walls. The average of the tests for this class of concrete placed during May and June was 2,300 lb. per square inch. The concrete in the arches containing 6 sacks of cement per yard would not flow, although it contained sufficient water to enable its being worked up to a quaking consistency. The average of the tests for the concrete in the arches at 28 days was approximately 2,800 lb. per square inch. The importance of keeping the water content of the concrete at a minimum consistent with workability was emphasized and impressed upon the construction organization, with the result that we were able to obtain results beyond our anticipations. The increase in strength from 2,300 to 2,800 lb. per square inch for concrete with the same combinations of solids but of different consistencies, is significant.

The mixture for the handrail was proportioned by cut and trial methods. Sample slabs were prepared with different combinations of the aggregates, and, after having been scrubbed and washed, these samples were placed side by side and compared. The proportion adopted was 1 cement : 2½ broken red granite : 1 granite dust : 1½ torpedo sand.

Construction Methods—The execution of this work involved no spectacular operations. The prescribed task was to construct the new bridge with a minimum disturbance of the dense traffic over the steel bridge, the center line of which lay west of the new bridge with the floors of the old and new bridges overlapping.

The substructures of the abutments and pier were constructed as units; the superstructure, including arches, walls, sidewalks, and fill, was constructed in two parts, the east half of the bridge having been completed and thrown open to traffic before the removal of the steel bridge, and the commencement of construction upon the west half. This plan was adopted on the ground of economy, and because operations might be conducted with the least interference with traffic.

Excavation for the abutments was commenced in December, was carried out with the usual derrick and skip or bucket equipment and because of the seasonal cold was expensive work. In preparing the foundations for the pier, an orange-peel bucket was used to remove a surface layer of rocks and boulders. A line of Wakefield sheetpiling was driven from leads suspended from a derrick boom and this piling backed by a puddle, the combination affording an adequate water seal whereby the water within the dam was kept down by a single centrifugal pump. In excavations for the abutments and approach walls, sufficient water was encountered to necessitate continuous pumping.

The concrete plant for the foundations included a paving mixer with a side-loading hopper for which extension leads had been prepared. In concreting the pier, this mixer was placed on cribbing at an elevation high enough to permit of dumping directly from the mixer to the pier. The cement, gravel and rock were placed in the loading hopper with wheel barrows at ground level, and elevated to the mixer over the extension leads. In concreting the abutments, the mixer was placed on the ground near the edge of the excavation, the aggregate placed in the side-loader with wheel barrows, and the concrete conveyed through chutes to place.

The water and aggregate for concrete placed during cold weather were heated and the spaces containing con-

crete were housed and heated for a considerable period after the placing of the concrete. Every effort was made to give the concrete the advantage of being cured under conditions as nearly normal as possible.

Sand and stone for the superstructure concrete were hauled to the site in automobile trucks and dumped into receiving pits from which they were raised into storage bins by a bucket elevator. This plant was so located in the west half of the north approach that it was possible to complete all concrete work without relocating the plant. The concrete was dumped from the mixer into side-dump cars and drawn to place over a light wooden trestle by a small gasoline dinky, the engine for which had been taken from a mixer. In placing the concrete for the sidewalk and spandrel walls, concrete buggies were drawn to place by the dinky on flat cars made in part of trucks from side-dump cars. The plant was cheap and eminently satisfactory; the results excellent.

The falsework was conventional, except perhaps, in the method employed to obtain the arch curve. In place of the standard practice of cutting the curves from the stringers, wedges and waste blocks and planks were added to build up the curves on plain stringers. Under this method much lumber otherwise worthless was used, and the stringers of new stock after having been used were available for further use thereby saving new lumber. Cinders for the fill were accumulated during the first half of the year in an adjacent vacant lot where they were loaded into dump carts with a light electric shovel and hauled to place on the bridge.

Construction began in December, 1920; the east half of the bridge was opened to traffic in August, 1921, and the west half in November. The street car traffic commenced on Dec. 1, 1921. The bridge was constructed under the direction of City Engineer W. P. Brereton, whose estimate of $250,000 was low in a competitive bidding. The bridge has been completed well within the contract price. A. L. Cavanagh was superintendent, Allan Cotman, chief draftsman, and J. F. Greene, consulting engineer.

Austral Super Dam or Dew Ponds Projected

Utilization of the principle underlying the ancient "dew pond," remains of which are still to be seen on the Downs of Sussex and Hampshire, England, is proposed on a large scale in Queensland, according to a correspondent of *The North Queensland Register* (London office, 22 Basinghall St., London, E.C. 2). The principle involved is that of condensing water from the air by bringing the water-laden air in contact with colder ground surfaces properly inclosed by embankments or by a dam across a valley. The promoters, of whom E. E. Kennedy of Brisbane, Queensland, is the leading spirit, have copyrighted the term "austral super-dam" as the name for their storage project. Supplementary to the information given in the journal quoted, it may be stated that some years ago there was published in England a book entitled "Neolithic Dew-Ponds and Cattle-Ways," by A. J. and G. Hubbard, (London and New York; Longmans, Green & Co.) A second edition of this book was reviewed in the Engineering Literature Supplement of *Engineering News* for Feb. 20, 1908. These ancient dew-ponds are also described by Richard Jefferies in his "Wild Life in a Southern County" (London, 1879); also an American edition under the title, "An English Village," published by Little, Brown & Co., Boston.

Experience in Treating Bridge Timber on the Santa Fe

40-Year Life Possible for Creosoted Ballast-Deck Bridge—Repair of Rotted Members—Value of Air Seasoning—Field Tests on Caps

By A. F. Robinson
Bridge Engineer, Atchison, Topeka and Santa Fe Ry., Chicago

Paper presented before the Western Society of Engineers in joint Meeting with American Wood Preservers Association.

THE first creosoted piles on the Santa Fe System were used in 1875 in an open-deck pile bridge across Galveston Bay. It was rebuilt in 1895. When the Causeway was finished the piles in the later bridge were removed and the larger portion of them were used again in pier foundations. The first creosoted ballasted-deck pile bridges were put into service late in 1899. The same season we used creosoted timber flooring on a ballasted-deck steel bridge at Los Angeles. When the joint track elevation bridges were built in Chicago creosoted timber flooring with waterproof covering was used for supporting the ballast. From 1900 the use of creosote increased rapidly and by 1908 almost all timber used in bridges was creosoted.

Creosoted ballast-deck timber bridges from 16 to 20 years old seem to be in perfect condition and give promise of 15 to 20 years more. These may, therefore, be considered as permanent structures. Some 38 per cent of all our bridges, which have a total length of 188 miles, are ballast-deck and almost 50 per cent are considered permanent structures. Based on main lines, only 68 per cent of all bridges have ballast decks. No open-deck bridges of any kind have been built on our main lines during the past 10 years, except after washouts or burnouts.

Creosoted-timber bridges had not been in service long before we found that there were many things to be learned about cutting, handling and curing before treatment; also handling the treated material and building the bridges.

Some of our troubles and the method of overcoming them may be worth recording. During 1909-1910 we had many complaints about rotten piling on our Beaumont division where timber seems to decay more readily than on any other part of our lines. A few miles east of Cleveland, Tex., is an experimental section, where we are trying out all kinds of treatment on ties, fence posts, etc. This section was taken because the soil and climate seemed to be especially adapted to produce rot in timber, both treated and untreated. I spent about four weeks going over this division, examining every pile bridge in the closest detail. The complaints were well founded. I found at least 2,000 piles that were rotting badly. The piling and timber used were treated in commercial plants from 1900 to about 1907. Up to that time no rules had been made covering the time the material was to be left in the woods after cutting and the time it was to be cured before treating. Many piles were treated which should have been culled. They were left in the woods several months and the material had commenced to decay before it was taken to the treating plant. In cases of this kind treatment is wasted. In many cases perfectly green piling and timber were treated.

Piles after driving in the bents are sawed off for capping. Our plans called for the application of hot creosote to these freshly-cut surfaces before the caps were applied, but a large percentage of the piles had begun to fail at the caps. Inside a layer or ring of sound creosoted sapwood would be a ring of untreated sapwood which was rotting very rapidly. The caps were 12 in. wide and the piles varied from 12 to 18 in. in diameter, leaving a portion of the pile head projecting beyond the sides of the caps. In some piles I could put a 4-ft. rod down in the rotten sapwood between the outer creosoted ring and the inner heartwood. In many cases much of the load was being carried by the outer creosoted ring of sapwood and but little load by the heartwood. In other cases, rot started at or near the ground surface. Decay also commenced in holes bored for sway-brace bolts and for other purposes. It would start wherever the creosoted surface was disturbed or bruised deeply.

Our men had the unfortunate habit of chamfering the sides of the piles at the cap so that they would drain. Frequently they would cut out large chips or sections from the side of a pile in order to make the swaybraces draw straight. In every case of this kind decay seemed to start very promptly as the cut in the timber usually extended through the creosoted layer. Careful study seemed to show that the cause of decay was due to leaving the heads of the piles or some other portions unprotected or untreated.

Another source of trouble was the driving of the piles. I found many cases where the heartwood had been broken loose from the sap, due to the fact that the blow from the hammer was being delivered into the pile over an area of less than one-half its surface. We overcame this difficulty by providing a driving head which rested squarely on the head of the pile and was so arranged that the blow from the hammer must be distributed over the entire surface of the pile. (See *Engineering News-Record*, Feb. 23, p. 314.)

As a remedy for the above troubles we cut down the decayed piles to good solid material and inserted framed bents or blocking of varying heights. When the piles were sawed the freshly-cut surfaces were treated with three or four coats of hot creosote mixed with heavy road oil. A sheet of some kind of prepared roofing was then applied over the fresh coating and the creosoted-timber bent put into position and drift-bolted to the piles. These repairs were made more than ten years ago and up to the present we have not been able to detect any more indications of decay.

When we cut these piles the cross-sections were examined very carefully and it was found that the creosote had penetrated the piles irregularly. On one side the treatment would be almost as thin as a sheet of paper and on the other side it might be 2 in. thick. We concluded that this unevenness was due to moisture in the piling, which resulted from the steaming and the improper seasoning.

When we opened our own treating plant at Somerville, Tex., all material was carefully air cured and no steaming of any kind was done in the treating process. As a result we have been able to get a very uniform penetration of the creosote. On the other parts of the system we have had very few piles fail at the caps, but where the trouble has occurred it has been overcome in the same manner as noted for the Beaumont division.

Examination of the stringers in ballast-deck bridges, which had been steamed in the treatment, showed a similar condition to the piling, but it was not so extensive. We have in a very few cases found some of the outer stringers decayed on the upper surface, as a result of the irregular penetration of the creosote. Where the timber is air seasoned and the treatment is applied without heating we have not had any trouble from decay in southern pine.

As the result of our trouble from rotting of piles at the caps we made quite an extended test on a field treatment of piles when cut for caps. With our first apparatus we were able to get 2-in. end penetration of the creosote. Several first-class creosoted piles were cut into lengths of about 3 ft. and also a similar number of untreated piles which were reasonably well seasoned. A part of these short creosoted specimens received the end treatment with our pressure apparatus. The other samples were painted with various kinds of preserving material and also several kinds of R. I. W. paint. After the coatings had properly dried these short pieces of piling were set up in a trench in the ground on our right-of-way 2 miles east of Cleveland, Tex. These pile butts were set 18 in. out of the ground, in an exact line and at the same elevation. A cap 12 in. wide and 4 in. thick was placed on top of the row of pile butts so that the test would be relatively the same as in the bent of a pile bridge.

We have examined these pile heads annually for eight years past. At present the samples of creosoted piles having pressure treatment on the ends and several of those receiving brush coatings on the ends are still in good condition. These investigations lead me to feel that a brush coating of hot heavy creosote, of Reeves Wood Preserver and Koch's R. I. W. paint will protect the freshly-cut head of creosoted pile for a long time. As yet I am not certain as to whether it will be necessary to use the pressure treatment for the ends of piles since the brush coating seems to be giving extremely good results. The application of the brush coating will cost considerably less than the pressure treatment.

Investigations made seem to show that the following rules in handling timber at the treatment plants must be adhered to absolutely:

1. Treated timber must not be cut, bruised or handled in a rough manner. Grab hooks or dogs should not be used in handling the material, unless the holes made by the hooks are carefully plugged with creosoted pins.

2. The driving of piles must be done with a hammer which will not split them or break the sap loose from the heartwood.

3. Any cut surfaces or bored holes must be carefully treated with hot creosote and the holes plugged.

Where solid stringers are used in a ballast-deck bridge without any cross planking it is necessary to make end cuts on some of the sticks on account of the variation in panel lengths of bridges due to driving of piles. These freshly cut ends must be thoroughly coated with creosote before the stringer deck is placed. A few years ago the Southern Pacific Lines in Louisiana and Texas removed the decks from 15 or 20 pile bridges which had been in service about 25 years. These decks were made of a solid course of 12 x 12-in. timbers and were removed because they were getting too light for the power being used. Examination of these stringers after being removed showed that they were in perfect condition as concerns decay, except where they had rotted in from the ends which had been cut after creosoting.

In open-deck timber bridges the stringers and ties are untreated, but for some years past the ties on open-deck steel bridges have been creosoted. The ties are always run through a surfacing machine and brought to exact depth. While Oregon fir loses quite a percentage of its strength as a result of steaming or boiling during treatment, we have had no stringers break under traffic. Fir caps in bridges built under our old standard plans have, however, given some trouble. A good many fir caps are "boxed heart" pieces and our ballast-deck bridges had too many drift bolts through the stringers into the caps. The failures in caps were always in Oregon fir pieces. In almost every case of failed caps I found that the timber was burned or charred in the boiling treatment and the sticks broken up into rings, much like the layers in an onion. Culling "'boxed heart" pieces and holding the boiling temperature to a maximum of 220 deg. F. very largely stopped the trouble with the fir caps.

Water Meters and Water Loss in Indiana

At the recent meeting of the Indiana Sanitary and Water Supply Association much attention was given to water meters and their beneficial results. E. J. Jenkins, manager, East Chicago Water Co., said that meters reduced the consumption at East Chicago from more than 200 gal. per capita late in 1920 to 70 gal. in December, 1921, when 12 per cent only was unaccounted for. William Luscombe, vice-president, Gary Heat, Light & Water Co., said 83 per cent of the water pumped to their 50 per cent metered system was accounted for. At North Manchester the loss is 6.77 per cent only. Lexington, Ky., the first all-metered city in the United States, according to W. S. Cramer, chief engineer, has 16½ per cent loss. Whiting has no meters. In 1920 the consumption was 4.2 m.g.d. or 420 gal. per capita. A house-to-house survey disclosed 700 leaky toilet fixtures. The consumption was reduced by 1 m.g.d., after repairs to services were made and a few large leaks in mains were shut off. J. B. Marvin, vice-president, Frankfort Water Co., said that of the $50,000 being spent by his company on new work, $33,000 was devoted to working the plant 100 per cent metered.

Placing 410,000 Cu. Yd. of Concrete on Ontario's Niagara Power Development—II

Source of Aggregate, Storage of Cement and Aggregate and Testing of Cement and Concrete for Power House, Forebay and Lining of Nine-Mile Queenston-Chippawa Canal

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AND

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Part I of this article, which appeared in last week's issue, described the concrete structures on the new hydro-electric development which the Hydro-Electric Power Commission of Ontario is building around Niagara Falls and detailed the many mixing and placing plants which produced 410,000 cu.yd. of concrete in the thirteen months ending last December. This section of the article describes the source of supply of the concrete material and the tests which showed how closely to a prescribed strength the various concretes ran. An earlier article on this method of proportioning and testing appeared in "Engineering News-Record," Mar. 17, 1921, p. 456.—Editor.

A TOTAL of 506,125 bbl. of cement has been used to date, obtained from five different mills. A large part was "bin tested," that is it was sampled, tested and accepted before it left the mill. To make this possible, special bins were reserved at the mills for the exclusive use of the commission. As these were filled, samples of the cement were taken from the conveyor and sent to the commission's laboratories at Toronto for test. Shipments were only made after cement was shown by the tests to be satisfactory, after which it was loaded as required under the supervision of a representative of the commission resident at the mill. As the design of the concrete plants permitted the handling of cement in car lots this arrangement proved a great convenience, since accepted cement could be used directly on receipt at the work, without either delay or rehandling.

Because of the severe cement shortage experienced in the summer of 1920 it was decided to store a large quantity of cement during the winter of 1920-21. Three large sheds, two 35 ft. wide and one 20 ft. wide and totalling 1,760 ft. in length were erected, in these were placed 112,000 bbl. of cement. This cement was stacked as compactly as possible to a height of 11 ft. The doors of the buildings were then sealed and not reopened again until the cement was used. All of this cement was stored over the winter and some of it for eleven months. Practically no cement losses occurred due to the hazards of storage while tests made showed it to have suffered no appreciable deterioration.

Aggregate.—The aggregates used throughout the work were sand and crushed rock. Sand was obtained from several different sources. The first came from a pit which was acquired along with other property as part of the right-of-way. From this pit came most of the sand used in 1917 and 1918. Later, after a careful examination of available sources of supply and after exploring the contiguous district for possible deposits, a pit was purchased which met the needs of the work until the spring of 1921 when it became necessary to obtain large quantities from other sources.

Aproximately 235,000 cu.yd. of sand were purchased. Half of this was obtained from a pit accessible from the tracks of the commission, and the rest from Lake Ontario. Both deposits contained materials of excellent quality.

The pit sand was loaded by steam shovel into side dump cars and delivered by the contractor either directly to the concrete plants or to the storage situated at the forebay. The lake sand was dredged from the bar at the mouth of the Niagara River by a sand sucker of 500 cu.yd. capacity which made four trips per day. This boat delivered the sand into a large storage bin situated alongside the Michigan Central tracks at Niagara-on-the-Lake, from which it was loaded by derricks fitted with clamshell buckets into standard steel dump cars. From here it was hauled 12 miles to the commission's siding at Stamford where it was picked up by the commission's locomotives and either distributed to the work or sent to storage if not immediately required.

Both sands used were of limestone origin, the pit sand having an average surface area of 2,130 sq.ft. and the lake sand of 1,680 sq.ft. per 100 lb. This is equivalent to a fineness modulus of 2.7 and 3.2 respectively. The former contained from 4 to 8 per cent by weight passing the No. 150 sieve while the latter had almost none of this fine material. To attain the same result under identical conditions, the pit sand was found to require approximately one-half bag of cement more for each yard batch of concrete than the lake sand due in part to the difference in graduation and in part to differences in the character of the constituent particles of the two aggregates.

Crushed Rock.—The crushed rock was a dolomitic limestone from the canal excavation. It was delivered as excavated to a 60 x 84 in. jaw crusher, when it was broken up, thence by belt conveyors to a battery of four gyratory crushers which reduced it to approximately 2½ in. stone and under. From these it passed to a screening plant where the dust was removed on a ⅜-in. dust jacket and the rock screened on a revolving screen 6½ ft. in diameter and 30 ft. long fitted with plates having 3-in. round openings which gave commercial 2½ in. screened crusher run. This was discharged upon a belt and taken to storage. The oversize from this screen went to a small gyratory crusher which crushed it to 1½ in. The product of this crusher was screened and stored separately and used where the larger sized material would be objectionable. The capacity of the crushing and screening plant was 3,000 cu.yd. per day and this capacity was reached in operation, the output averaging close to this figure for extended periods.

The grading of this crushed rock was practically

uniform between ¼ and 2½ in. It contained on an average 8 per cent of dust and crusher screening. These could not be entirely eliminated because of the nature of the rock and the fact that it was usually wet and somewhat dirty when crushed. It was reasonably free from flat and elongated particles and proved to be a satisfactory aggregate.

The choice of 2½ in. as a maximum size was a compromise between the requirements of the concrete and of the large quantities of crushed rock which were to be used for ballast, highways, foundations and fill. If only the requirements of the concrete could have been considered a smaller maximum size would have been more satisfactory, for its use would have been less severe on the concreting plants and the concrete would have been easier to handle and place. Since of the 1,262,000 cu.yd. of stone crushed to date less than 400,000 cu.yd. were used in concrete (a part of which had already been crushed to 1½ in.) this decision as to size has proved wise.

Aggregate Storage.—The principal storage was at the forebay in conjunction with the crushing plant. Large towers were built at each end and in the center of the storage area. From these towers a platform was suspended carrying a belt conveyor with a traveling trip by which it could be discharged. This permitted distribution of the material to any part of the area desired.

The stone was fed directly to its conveyor from the screening plant. The sand which was received in cars, was run over hoppers and dumped. From these it was elevated by a bucket conveyor up the intermediate tower to the sand conveyor overhead by means of which it was distributed similarly to the stone. It was thus possible to keep the two kinds of sand separate. The stone storage had a capacity of 160,000 cu.yd. of 2½ in. and 70,000 cu.yd. of 1½ in. while the sand storage had a capacity of 50,000 cu.yd. and this was taxed to the utmost during the progress of the work.

When in July it was decided to delay completion of the canal beyond September it was found necessary to find some auxiliary storage for some of the lake sand as it was then being received faster than it could be used. Hence some 40,000 cu.yd. were dumped on a level field convenient to the construction railway from which it was later reclaimed by steam shovel.

The storage piles of both sand and stone were close together and had a common center line along which a covered trench was constructed the full length of both piles. In this tunnel ran a reclaiming belt fed by bin gates from above. After leaving the tunnel the belt rose on an angle of 18 deg. to storage bins from which the aggregate was loaded by gravity into cars for distribution to the concrete plants. A feature of this arrangement was the use of this belt for reclaiming either sand or stone as desired, discharge end being rigged with a gate which diverted the reclaimed material into either the sand or stone bin.

Four classes of concrete, called for convenience Classes *A*, *B*, *C* and *D* were in use on this work. Class *A* was specified as being of such quality as to show a minimum compressive strength of 2,500 lb. per square inch at the age of 28 days when tested in accordance with the standard methods of the Commission. Classes *B*, *C* and *D* were required to have minimum compressive strengths of 2,000, 1,500 and 1,000 lb. per square inch, respectively, under the same conditions. The standard methods of testing referred to are essentially those adopted by the American Society for Testing Materials.

Such a specification made it incumbent upon the field engineers so to regulate the materials, proportions and practices of the construction forces as to result in concrete of the specified quality. To carry out this a very complete system of inspection was maintained and a field laboratory installed.

Inspection commenced with the materials and at their sources of supply. Inspectors were kept at points from which sand was being obtained at the crushing plant and at the cement mills. Those inspecting sand shipments were supplied with sieves for testing and were required to report daily on the quality and grading of the materials shipped under their supervision. Sand not meeting the requirements of the commission was not allowed to be loaded and never got to the work.

One or more inspectors were placed at each of the concrete plants. Their duties were the usual duties of a concrete inspector but they had the power to vary within certain limits the proportions set by the egineers to conform to the inevitable variations in materials and for the changing conditions under which the concrete had to be placed, They were also required to take periodically from the forms samples of the concrete and prepare these for testing.

The field laboratory was equipped with a 100-ton hydraulic compression testing machine of simple and inexpensive design and the usual equipment of sieves, scales and miscellaneous apparatus for testing aggregates. Space was also provided for the storage of concrete test cylinders during the curing period.

Proportions for the different classes were set by the chief field inspector and were determined by a modification of Edwards surface area method of proportioning, as developed in the laboratories of the commission. By this method not only were the proportions of cement and aggregate set but also that for the water. This was accomplished by limiting the quantity of water per bag of cement for each class of concrete. The consistency of the mixtures used was such as to flow readily but without segregation down a chute with a slope of one vertical to two and one-half horizontal. Where the consistency could not be obtained with the proportions set or where circumstances required a wetter mixture additional cement was added until the ratio of water to cement was brought within the limits set. In other cases where a drier consistency could be used, advantage was taken of the circumstance by using less cement, always maintaining the proper ratio of water and cement.

Results of Tests.—That these methods resulted in concrete of uniform quality fully meeting the specifications is evident from its excellent appearance and the results obtained upon test. In Table I are given complete results from the tests of concrete placed in the powerhouse and canal lining during the months of May to July or through the height of the period when work was being rushed to the uttermost. The results speak for themselves. On the entire job from Nov. 1, 1920, to Nov 1, 1921, 74 per cent of the test cylinders either met or exceeded the specification requirements while 87 per cent either met them or did not fall below them more than 200 lb. per sq.in.

TABLE I. COMPRESSION TESTS ON FIELD CYLINDERS
CHIPPAWA POWER DEVELOPMENT
May 1 to July 31, 1921, inclusive

POWER HOUSE

Class B

Date Taken	Nominal Proportions By Volume	Compressive Strength 28 Days Lb. per Sq.In.	Date Taken	Nominal Proportions By Volume	Compressive Strength 28 Days Lb. per Sq.In.
May 9	1:1.83:3.66	2,655	June 16	1:1.83:3.66	2,775
May 16	1:1.83:3.66	2,435	June 21	1:1.83:3.66	3,750
May 19	1:1.83:3.66	2,322	June 23	1:1.83:3.66	2,785
May 26	1:1.83:3.66	2,680	June 29	1:2.44:4.88	1,927
May 30	1:1.83:3.66	2,449	July 1	1:1.83:3.66	2,280
June 2	1:1.4 :4.4	2,180	July 16	1:1.83:3.66	2,324
June 4	1:1.83:3.66	2,443	July 20	1:1.83:3.66	2,398
June 7	1:1.83:3.66	2,140	July 30	1:1.83:3.66	.....

Class C

May 2	1:2.5 :5	1,253	June 18	1:2.44:4.88	2,420
May 5	1:2.5 :4.25	1,920	July 5	1:2.44:4.88	1,802
May 11	1:2.44:4.88	1,728	July 8	1:2.44:4.88	1,941
May 14	1:2.44:4.88	1,725	July 12	1:2.44:4.88	1,703
May 28	1:2.44:4.88	1,855	July 14	1:2.44:4.88	1,304
June 9	1:2.44:4.88	1,825	July 26	1:2.44:4.88	2,030
June 11	1:2.44:4.88	2,198	July 28	1:2.44:4.88	1,027
June 14	1:2.44:4.88	2,345			

CANAL LINING PLANTS

Class C

Date Taken	Nominal Proportions By Volume	Compressive Strength 28 Days Lb. per Sq.In.	Date Taken	Nominal Proportions By Volume	Compressive Strength 28 Days Lb. per Sq.In.
May 4	1:2.5 :5	2,935	June 16	1:2.5 :4.8	2,755
May 6	1:2.5 :5	2,687	June 17	1:2.8 :4.4	2,360
May 6	1:2.5 :5	1,555	June 19	1:2.5 :4.8	2,310
May 9	1:2.5 :5	3,066	June 19	1:2.2 :4.8	1,797
May 9	1:2.5 :5	1,673	June 20	1:2.5 :5	1,710
May 11	1:2.5 :5	1,910	June 21	1:2.2 :4.8	1,912
May 13	1:2.8 :4.4	2,050	June 21	1:2.2 :4.8	1,840
May 14	1:2.5 :5	1,877	June 22	1:2.5 :5	1,652
May 16	1:2.8 :4.4	1,633	June 23	1:2.2 :4.4	1,590
May 16	1:2.5 :5	1,077	June 24	1:2.2 :4.8	1,780
May 18	1:2.8 :4.4	1,843	June 25	1:2.2 :4.4	2,935
May 18	1:2.4 :4.4	1,827	June 26	1:2.5 :4.8	1,810
May 19	1:2.5 :5	1,865	June 29	1:2.2 :4.2	1,720
May 20	1:2.8 :4.4	1,820	June 29	1:2.77:5.55	1,450
May 20	1:2.5 :5	1,930	June 30	1:2.5 :5	1,548
May 23	1:2.5 :4.16	1,743	July 1	1:3.11:4.88	1,768
May 23	1:2.5 :5	1,292	July 2	1:2.2 :4.4	2,071
May 25	1:2.5 :5	1,922	July 4	1:3.11:4.88	1,607
May 25	1:2.5 :5	1,868	July 5	1:2.2 :4.2	1,892
May 27	1:2.5 :5	2,445	July 5	1:3.12:6.25	1,390
May 28	1:2.5 :5	2,145	July 6	1:2.77:5.55	1,921
May 30	1:2.8 :4.4	1,845	July 7	1:2.2 :4.4	2,025
June 1	1:2.5 :5	1,865	July 8	1:3.11:4.88	1,472
June 2	1:1.33:4.06	1,845	July 11	1:2.77:5.55	1,412
June 3	1:1.28:4.44	1,886	July 12	1:2.2 :4.2	1,152
June 4	1:2.5 :4.8	1,688	July 13	1:2.77:5.55	1,530
June 4	1:1.45:4.36	1,720	July 14	1:2.5 :5	1,782
June 6	1:3.12:6.25	1,593	July 15	1:3.11:4.88	2,447
June 6	1:2.5 :5	1,428	July 15	1:2.2 :5	2,012
June 6	1:2.5 :5	1,488	July 20	1:2.2 :5	2,605
June 6	1:3.12:6.25	1,247	July 20	1:2.77:5.55	2,178
June 7	1:1.33:4	3,294	July 20	1:2.44:4.88	1,414
June 8	1:3.12:6.25	1,912	July 20	1:2.77:5.55	1,397
June 8	1:1.83:3.83	2,425	July 22	1:2.77:5.55	877
June 8	1:2.5 :5	2,853	July 22	1:3.11:4.88	1,513
June 8	1:2.4	2,396	July 25	1:2.77:5.55	2,549
June 10	1:2.8 :4.4	2,482	July 26	1:2.5 :5	1,613
June 10	1:2.2 :4.6	3,175	July 27	1:2.5 :5	1,515
June 11	1:2.5 :5	1,892	July 27	1:3.11:4.88	1,495
June 12	1:2.2 :4.8	1,594	July 27	1:2.44:4.88	1,435
June 13	1:2.5 :5	1,782	July 29	1:2.77:5.55	1,445
June 14	1:2.5 :4.8	2,403	July 30	1:2.5 :5	1,603
June 14	1:2.4 :8	1,320	July 30	1:2.5 :5	1,559
June 15	1:2.5 :5	1,677	July 30	1:2.77:5.55	1,399
June 16	1:2.5 :5	2,165			

Class D

May 13	1:3.12:6.25	1,663	June 22	1:3.11:4.88	1,632
May 30	1:3.12:6.25	517	June 24	1:3.11:4.88	2,365
June 2	1:2:5	1,158	June 27	1:2.77:5.55	2,165
June 14	1:2.75:5.5	2,018	July 14	1:3.12:6.25	990
June 17	1:2.75:5.5	1,692	July 19	1:3.57:7.14	814
June 20	1:2.77:5.55	1,905			

The average amount of cement used per cubic yard of concrete of all classes on this work has been 1.28 bbl. of 350 lb. net weight, the Canadian standard barrel of cement, equivalent to 1.19 bbl. in American units. The averages for the different classes have been as follows:

Class	Minimum Compressive Strength at 28 Days Lb. Per Sq.In.	Barrels of Cement Per Cu.yd. of Concrete Can. Bbl.	U. S. Bbl.
A	2,500	1.67	1.55
B	2,000	1.46	1.36
C	1,500	1.20	1.12
D	1,000	0.98	0.91

At times as much as an extra bag of cement above this average would be required to obtain the desired results but more often it was possible to meet the requirements of the specifications with less than the figures shown, for example Class *C* concrete has required as much as 1.45 bbl. (1.35 U. S. bbl.) of cement per cu.yd. while on the other hand the necessary requirements been obtained for extended periods with a 1:2¾:5½ mixture using 1.01 bbl (0.94 U. S. bbl.) per cu.yd.

Calcium Chloride.—During the winter of 1920-21 and again last fall, calcium chloride was used in the concrete place in the canal lining to accelerate hardening and so prevent a slowing down in the production of the lining plants. The quantity used varied from 6 to 15 lb. per yard batch, but averaged 9 lb. or about 2¼ per cent by weight of the cement in the mixture. The chloride was delivered to the plants in drums and was dissolved as required. The method usually followed was to fill a barrel with water to a mark set by the inspector: next was added chloride until the water level rose to a second mark, steam then being admitted into the barrel to dissolve the chloride until the level of the mixture rose to a third mark when a solution of the desired strength would result. No attempt was made to obtain greater accuracy in the measurements as this was not found necessary. Two gallons of this mixture was added to each batch of concrete by discharging it into the barrel used to proportion the water. A very noticeable increase in early strength was obtained and by its use it was possible to strip forms in as short a time as 12 hours even in freezing weather.

TABLE II—CONCRETE PLACED ON QUEENSTON—CHIPPAWA POWER DEVELOPMENT
(Week Commencing June 20, 1921)

Plant	Cubic Yards Placed
Powerhouse	1,162
Screenhouse	1,319
Forebay	151
Forebay (Gunite)	40
Division III	
No. 1 Lining Plant	998
No. 2 Lining Plant	137
No. 3 Lining Plant	1,131
No. 4 Lining Plant	1,306
No. 5 Lining Plant	1,866
No. 6 Lining Plant	2,170
Curve Lining Plant	336
No. 1 Paving Plant	137
No. 2 Paving Plant	219
No. 4 Paving Plant	172
No. 5 Paving Plant	966
Montrose Stationary Plant A	1,381
Whirlpool Stationary Plant	4,787
Total	18,278

From Nov. 1, 1920, to Dec. 17, 1921, 410,000 cu.yd. of concrete were placed, 379,000 cu.yd. of this being placed in 1921 while 332,000 cu.yd. of this latter quantity were placed from May to December inclusive or at an average rate of 41,500 cu.yd. per month. The record day's pour was 3,046 cu.yd. with 17 plants operating, the record week, 18,278 cu.yd. and the record month, 63,362 cu.yd. An idea of the diversity of operations is obtained from Table II which is the record of concrete placed during the record week.

Sir Adam Beck is chairman of the commission, for which Fred. A. Gaby is chief engineer, H. G. Acres, hydraulic engineer, T. H. Hogg, Assistant hydraulic engineer and M. V. Sauer, engineer of design. The work is in charge of H. G. Acres under whom G. H. Angell is general superintendent and A. C. D. Blanchard, chief field engineer.

Design of Sand Box for Kern River Hydro-Electric Plant

Operation of High-Head Reaction Turbines Demands Clear Water—Test Shows 400-Ft. Tank Settles Particles Passing 200-Mesh Sieve

By H. L. Doolittle
Assistant Construction Engineer, Southern California Edison Co.

IN ORDER to preclude the entrance of sand into the vertical reaction turbines installed at the Kern River No. 3 plant of the California Edison Co., every precaution was deemed advisable. The hydro-electric installation consists of two 22,500-hp. vertical turbines in this case operating under an 800-ft. head and utilizing 300 sec.-ft. A turbine of this type with high velocity and small clearances would suffer considerable damage if any appreciable amount of sand were carried in the water. In order to remove the sand from the river water, the sand box or settling basin herein described was constructed. The sand box is located near the diversion dam, about 12 miles upstream from the power house.

To be successful a sand box must accomplish two things: Cause the sand to settle out of the water; and provide for the easy removal of the sand from the settling chamber. In the present case it was necessary to provide for 600 sec.-ft. of water, so it is readily seen that some unusual problems presented themselves.

Centrifugal means of separating the sand from the water were considered entirely impracticable because of the amount of water handled. From a study of available literature it was decided that if the velocity of the water were reduced to 0.5 ft. per second, all sand particles of a size sufficient to cause damage to turbines would be precipitated. This, then, determined the cross-sectional area of the sand box to be 1,200 sq.ft. A size 20 ft. by 60 ft. was adopted.

In the design of the ordinary sand box the reduction of velocity is usually accomplished by means of a gradually-increasing section of the waterway. Too often the increase in area of the section is very abrupt, resulting in a rather swift current flowing through the center of the sand box and thereby defeating the very purpose of the structure. It is generally conceded that, if the angle of flare is about 6 deg., the water will entirely fill the section and will flow with almost a uniformly-decreasing velocity. In the case in point, if a constantly-increasing area were relied upon to decrease the water velocity, it would have required a taper section about 600 ft. long to give the waterway a width of 60 ft. While this type of structure would be effective it may be objected to because the cost would be great and in many places the space required would not be available.

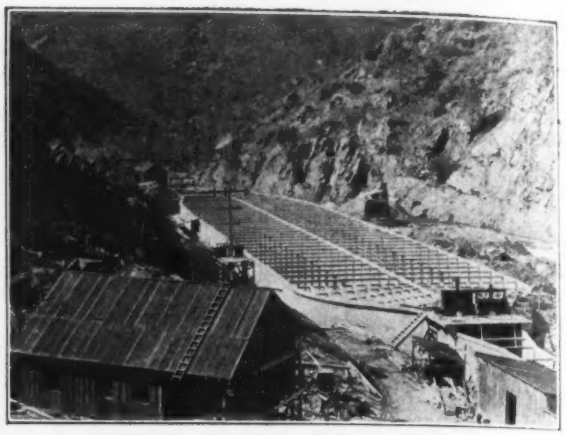


FIG. 2—GENERAL VIEW LOOKING DOWNSTREAM

Deflecting Walls—It is therefore seen that it is highly desirable to reduce the velocity of the water to a minimum in the shortest possible distance. This was accomplished by means of deflecting walls at the entrance to the sand box. By means of these deflectors the water is forced to distribute itself uniformly over the entire width of the box and is not allowed to flow through the center. As it was thought that there might be some tendency for the water to flow unevenly between the deflecting walls, their upstream edges were made movable. With this arrangement the water is distributed across the entire width of the box in a length of 50 ft., compared to the length of 600 ft. required with the ordinary tapering section.

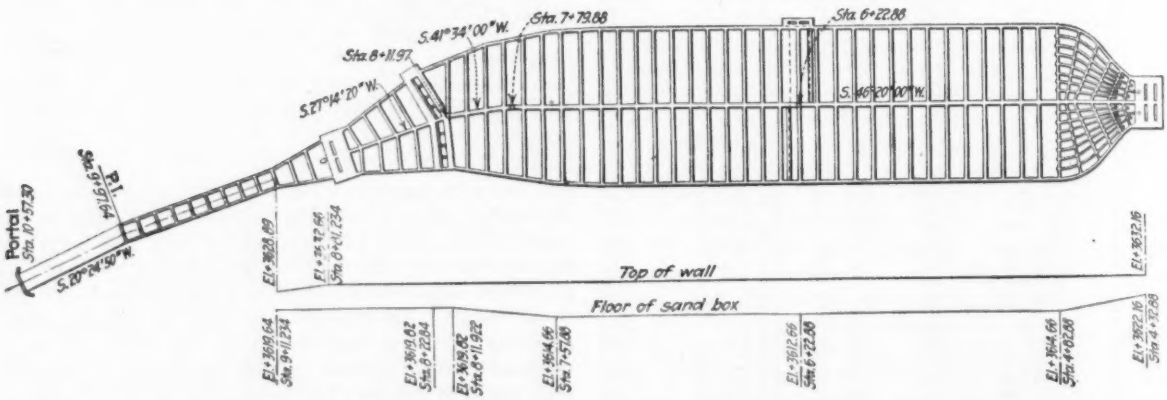


FIG. 1—PLAN AND PROFILE OF SETTLING BASIN

Sand Removal—The removal of the sand from the bottom of the box is next to be considered. The most common method is to install several valves or sluice gates in the bottom of the box. While such devices are effective in removing the sand directly in their vicinity it has often been observed that only a cone of sand is removed and a considerable quantity is left

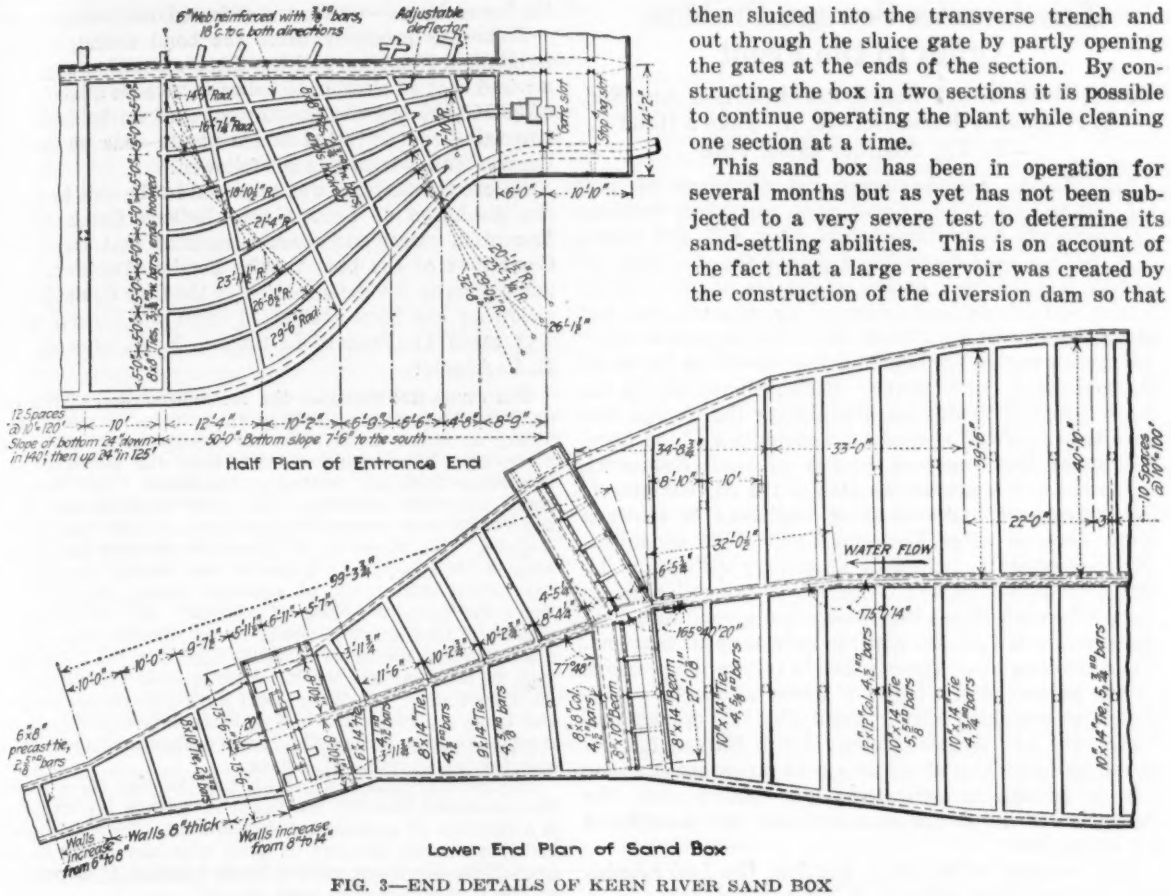

6" Web reinforced with ⅜" bars, 18" c. to c. both directions
Adjustable deflector
Gate slot
Stop log slot
Half Plan of Entrance End
Lower End Plan of Sand Box
WATER FLOW
Walls increase from 6" to 8"
Walls 8" thick
Walls increase from 8" to 14"

FIG. 3—END DETAILS OF KERN RIVER SAND BOX

between the valves. In addition it is desirable to have as few valves as possible, minimizing upkeep and water leakage.

On the Kern River project sand removal was effected by sloping the bottom toward a trench in the center, this trench connecting to a 4 x 5-ft. sluice gate in the side of the box. The box was made in two compartments with motor-operated gates at both ends. In removing the sand the gates at the ends of one-half of the box are closed and the sluice gate in the side is opened. This unwaters one-half of the box leaving the greater part of the sand on the bottom. The sand is then sluiced into the transverse trench and out through the sluice gate by partly opening the gates at the ends of the section. By constructing the box in two sections it is possible to continue operating the plant while cleaning one section at a time.

This sand box has been in operation for several months but as yet has not been subjected to a very severe test to determine its sand-settling abilities. This is on account of the fact that a large reservoir was created by the construction of the diversion dam so that practically all of the larger particles of sand are settled before the water enters the sand box. This condition is only temporary, as the reservoir will soon be filled.

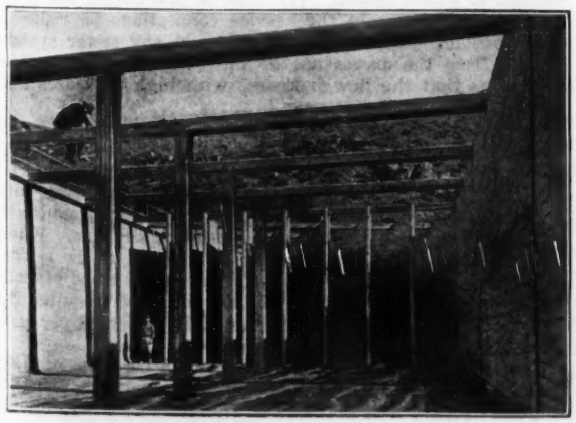


FIG. 4—DEFLECTOR WALLS AT SAND BOX ENTRANCE

Tests Show Effectiveness—Coarse sand is quite easy to remove. The finer particles cause the greater concern. However, a recent inspection of the sand box indicates that it is effective in settling very fine particles. When the box was unwatered a layer of fine sand and mica particles about 6 in. deep had been precipitated on the downstream half of the floor. There was no coarse material as this had collected above the dam. An analysis of the precipitated sand showed that 45 per cent passed a 150-mesh sieve and 26 per cent passed a 200 mesh. This would seem to show that the sand box is accomplishing all that could be expected.

The sand box is constructed entirely of reinforced concrete, the walls being tied across the top and bottom. The drawings show the box to be about 400 ft. long. This is more or less an arbitrary figure as there were no data at hand to show how long it requires a particle of a given size to settle out of water flowing at a certain velocity. From observations so far it is thought that the length is sufficient for all practical purposes.

Typhoid Fever From Water Held Compensable

Typhoid fever contracted from impure water furnished by an employer is held an "injury" by "accident arising out of and in the course of the employment" under the Workmen's Compensation Act of Indiana, according to a decision of the Appellate Court.

Los Angeles Sewage Problem Again to the Front

Court, State Health Board, Local Section Am. Soc. C. E., County Farm Bureau, All Take a Hand —To Try Another Bond Vote

SINCE Los Angeles began the discharge of raw sewage into Ballona Creek as an emergency measure (*Engineering News-Record*, Feb. 23, p. 366, and March 2, p. 343) a local court has enjoined the discharge of sewage into the creek on the application of Culver City, Venice and private land owners along the creek, but has given the city 60 days from March 28 to provide other emergency means for handling the flow from the overcharged ocean outlet sewer. Recommendations by the State Board of Health for diminishing the sewage flow have been reported against by a committee of the Local Section of the American Society of Civil Engineers, which has also approved the plan of the city's engineering department and consulting engineers to continue ocean disposal after fine screening. This committee advises against any attempt at sewage utilization, by means of activation and irrigation or otherwise unless those who wish to use the sewage for agricultural purposes will stand all the expense necessary to that end. The committee also suggests that to relieve the pressure on the present ocean outlet a series of pumps be installed, as explained below. Besides all this opinion and advice, the Los Angeles County Farm Bureau has renewed its opposition of a year ago to a new outlet sewer and is advocating activated-sludge plants with the utilization of the sludge as a fertilizer and the effluent for irrigation.

After months of apparent inaction, the Los Angeles City Council has ordered a referendum vote on a $12,800,000 sewerage bond issue at the primaries on Aug. 12, with, it is said, no other bond issue on the ballot. Apparently this will be a second vote on the plan voted down 5 to 3 on June 7, 1921. The defeat just mentioned was the third one in five years, settling tanks and sludge beds having been voted down in 1916 and 1917. The election held in June, 1921, was postponed from a date earlier in the year, when the people were to have voted on a plan for a new outfall and drum screens worked out by the W. T. Knowlton, sewer engineer and John T. Griffin, city engineer (see abstract of a paper by Mr. Knowlton, *Engineering News-Record*, Feb. 24, 1921, p. 331; this article also brings out the overcharged condition of the present outfall). Opposition to the proposed election from various quarters and requests for export opinion on the projects led to cancelling the election and the engagement of George W. Fuller, Prof. George C. Whipple and William Mulholland to review the project (see *Engineering News-Record*, March 17 and June 30, 1921, pp. 484, and 1117, the latter being an abstract of the committee's report). The committee approved in substance the plans of the city engineering department for a new outfall and screens but advised more expense for multiple dispersal of the screened sewage and for protection of the interior of the outfall against acids. It also recommended the construction of a 2.5-m.g.d. activated-sludge plant to throw light on the possibilities of sewage utilization. To meet these increased costs a bond issue of $14,000,000 instead of $12,850,000 was recommended by the consulting engineers, but the city authorities submitted the lower figure—which was defeated, as already stated.

Following promptly after the bond defeat, Messrs. Griffin and Knowlton and the three consulting engineers advised that an election be called to vote on a bond issue of $3,500,000 to build temporary relief works, including two fair-sized activated-sludge plants—one on Ballona Creek. This advice was not followed.

Before the decision was rendered in the suit to enjoin the discharge of sewage into Ballona Creek, W. T. Knowlton, sewer engineer, suggested that the Sewer Committee of the Los Angeles Section Am. Soc. C. E. make a report on the situation to the City Council. The following has been abstracted from the report, which was made by Francis L. Sellew, F. G. Dessery and E. L. Adams:

The committee endorses the recommendation of the city engineer that steps should be taken at once toward providing an ocean outlet, with no pre-treatment except fine screening. The committee points out: (a) Ocean disposal is cheaper than any method of treatment. (b) No financially successful treatment has ever been devised for a community even remotely approaching in size that of Los Angeles. (c) There is no immediate demand for sewage effluent for irrigation. There is now wasted for half the year about 200 sec.-ft. of aqueduct water, which is four times the present volume of sewage. (d) Irrigation demands, if they existed, would be so variable that partial discharge into the ocean would be necessary for the greater part of the year and during some seasons the entire flow must go there. (e) When local anticipations are realized and there are two and a half to three million people in Los Angeles County, there will be little agricultural areas available for the reception of sewage.

The general conditions which Los Angeles faces justify the conclusion that the treatment of sewage for irrigation is a function of agricultural development. Provision should be made for the delivery to those who may desire it, and are willing to assume all the further burden of disposal, of all the raw-sewage they may request.

The importance of protecting the popular bathing beaches warrants care in means of disposal beyond the actual sanitary requirements. The method of disposal adopted should be so effective as to make it impossible to detect the presence of sewage in the surf by chemical analysis or otherwise. The point of discharge should be submerged at least 50 ft., with multiple outlets and no sewage visible from shore.

The committee is unable to endorse any of the three following suggestions made to the city by the State Board of Health under date of Feb. 4: "(a) That further petitions for residential connections, tributary to the outfall sewer be denied. (b) Divert into storm drains or natural water courses, all possible industrial waste water which, in the opinion of the City Health Department, will not be a menace to public health. (c) That if practicable the present water pressure in the service connections be reduced, as a considerable portion of the flow in any sewer system results from the excess use of water, and experience has taught us that the flow increases with high pressures and decreases with low pressures."

Since the overloaded sewer is not strong enough to carry additional pressure, the committee suggests that its capacity be increased by the installation of a series of pumps placed so as to increase the hydraulic slope. Under this plan only a short length of the outfall would be under pressure, a suction effect being exerted along most of the line. When the slope above one pump reaches the crown of the sewer, another unit would be installed to increase the slope beyond. Approximately ten pumping units would be required to enable the present outfall to deliver at Hyperion 30 per cent more than its present maximum.

Immediate ocean disposal for the entire city of Los Angeles should have the active indorsement of the Los Angeles Section, Am. Soc. C. E. The design should provide for the most thorough and comprehensive plan possible, with provision for a future metropolitan district.

In the decision already mentioned, which was handed down March 28 by J. Perry Wood, judge of the Los Angeles County Superior Court, the city of Los Angeles is declared to be creating an intolerable nuisance by discharging sewage into Ballona Creek and complainants are granted an injunction against the city (effective after 60 days) to prevent the continuation of the nuisance. An abstract of the decision is given in the following paragraphs:

The expert evidence indicates that chlorination would not sufficiently remove the dangers and objections attending the discharge of sewage into Ballona Creek and that the city has taken an untenable position in claiming that it has nowhere else to put its sewage. The recommendation of the State Board of Health is to the effect that decreasing water pressure decreases sewage flow, that industrial waste water could be diverted into storm drains or natural water courses and that further residential connections could be denied and cesspools permitted as emergency measures.

A storage reservoir which could be built in sixty days and which would have a capacity sufficient to hold the excess sewage which, for a part of each day now flows into Ballona Creek, would remedy the present situation if the quantity of flow did not increase. Such a reservoir could be pumped or drained into the outfall in the night time.

Within sixty days the city could provide other emergency disposal means; an activated-sludge plant to care for the excess flow of sewage for a period of years could be constructed and installed within six months; within the three-year period a new outfall sewer or additional activated-sludge units could be provided.

No announcement regarding a possible appeal from this decision or any other resultant action by the City Council has been received by this journal.

Estimated and Average Daily Water Consumption in St. Louis

COMPARATIVE figures of estimated and actual average total daily water consumption in St. Louis, Mo., by years from 1914 to 1921 agree closely except for variations due to abnormal weather. For the maximum day and for the average for the maximum week and maximum month there is, naturally, more variations. The figures, taken from a paper read recently by Edward E. Wall, water commissioner of St. Louis, before the Associated Engineering Societies of St. Louis, are given in detail in the accompanying table. Mr. Wall points out that war conditions had less to do with the departures from the estimates than did unusually dry or unusually cold weather.

From the figures given in the table Mr. Wall concludes that the annual daily average will be exceeded by 125 per cent for the maximum month in any year, by 135 for the maximum week, and by 150 per cent on the maximum day.

DAILY ESTIMATED AND ACTUAL FIGURES OF WATER CONSUMPTION IN ST. LOUIS, MO.

Year Ending Apr. 1	Population		Average Water Consumption in Million Gallons: Maximum Day		Maximum Week		Maximum Month		For the Year		Remarks
	Estimated	Actual	Estimated	Actual	Estimated	Actual	Estimated	Actual	Estimated	Actual	
1914	729,000	725,500	136.7	120.0	123.0	112.0	114.0	105.0	91.1	91.1	Normal
1915	740,000	734,500	138.0	134.0	125.0	128.4	115.5	116.8	92.5	88.7	Cool summer; low consumption
1916	752,000	743,000	140.4	112.5	126.3	104.3	117.0	95.0	93.6	94.8	Normal
1917	765,000	751,500	114.0	131.4	130.0	124.7	120.5	116.3	96.2	101.2	Hot summer; consumption heavy
1918	778,000	760,000	148.2	163.0	113.6	146.3	124.0	116.9	99.0	105.1	Dry and hot summer; excessive consumption
1919	791,000	768,500	152.5	145.0	137.3	133.1	127.0	121.7	101.7	102.1	Normal
1920	804,000	777,000	156.5	137.1	141.0	131.0	130.5	122.4	104.5	104.6	Normal
1921	817,000	785,500	160.8	141.0	146.0	148.4	134.0	127.3	107.4	104.5	Seasonable summer; mild winter; consumption below normal.

Why Reform in Engineering Contracts Is Necessary

(Excerpts from an address by Gen. R. C. Marshall, Jr., of the Associated General Contractors, before the American Railway Engineering Association, March 15, 1922.)

There are hundreds of contract forms used throughout construction, which vary greatly in their obligations. It is difficult for the field force as well as the management to keep in mind the detail requirements of every job. I have in my office some 200 contract forms used all over this country. I think there can be no greater commentary on the lack of business methods of engineers and architects.

One of the great criticism heard concerning the construction industry is that it is not managed along the lines recognized and established in other industries, and that it is far behind in matters of estimating and cost accounting. This condition will not be overcome until the basic agreements under which they work are brought into some semblance of harmony. Under one contract the construction company has certain obligations and under another contract the obligations are entirely different.

Many revelations of conditions existing in the building and general construction industries, during the past two years, show a need of better understanding between that industry and the other industries for which it works. It should be clearly understood that many practices which have arisen in the building industry are traceable to the contracts under which that industry has been conducted.

It is only in recent years that building contracts have been drawn so that they contained any semblance of mutuality. It was within the power of an architect to practically make or break a contractor. Construction costs for the same result ran higher under one architect than another.

In the case of the railroads, some years ago, construction contracts as drawn by the legal department were about in keeping with the general policies of sovereignty pursued by the roads, and had it not been for the fairness with which engineers administered these contracts it is questionable whether railroad development could have taken place. The contractor on railroad work depended more upon the personal equation of the engineer than upon the contract. As a matter of fact, the contract meant little either to the chief engineer or to the contractor. If the chief engineer died all conditions of the contract were immediately changed. No rules of economics are served under such conditions.

In December a committee representing eight great national associations got together to consider this subject. The committee determined that there are a number of subjects that are common to all forms of construction work. But it did not determine definitely that the subject matter of these subjects could be so expressed as to be acceptable in every case.

It has been suggested that a universal construction agreement be adopted which will cover the obligations common to all work, leaving to several sets of general conditions those provisions which are peculiar to each individual type. In such manner it would be possible to establish clearly the obligations of construction and to build up a strong foundation of precedents which would establish an ethical practice throughout.

Successful Spring Meeting Held by Am.Soc.C.E. at Dayton

Flood Protection the Subject of a Dozen Notable Papers—Local Protective Work Inspected—Col. Deeds Delivers Valedictory of Conservancy District Construction—More Than 350 Present

IN MEETING at Dayton last week, April 5 to 7, the American Society of Civil Engineers made trial of a radical departure from time-honored practices. Hitherto the January annual meeting and the summer convention were the only gatherings outside of the monthly New York meetings. Dayton was the scene of the first spring meeting. Appropriately, flood protection was the theme. The occasion attracted an attendance well exceeding 350, and aroused interest, not to say enthusiasm, hardly equalled at prior meetings.

Technical Program.—There was a strong program of technical papers. Reviews of flood conditions in various parts of the United States and a sketch of the Chinese situation were presented, besides more special discussions. The Miami work was briefly summarized, with highly impressive effect because the approaching completion of the great enterprise made the meeting in a sense an inaugural celebration. Col. E. A. Deeds, the inspiring head of the Miami Valley protection movement, in an address of reminiscence described the occasion as the valedictory of the work.

From the interest exhibited by the members, a prime feature of the meeting was a discussion of small-area floods, or cloudburst floods, in two papers. Both authors emphasized the startling lack of data on this type of flood, described as perhaps the most important source of flood loss in the United States. In this connection action by the Board of Direction to form a research committee on Flood Protection Data promises to prove specially significant.

Important steps in the development of society affairs were taken by the Board in its session preceding the meeting of the society. These were reported last week.

Inspection Trips.—Due to the planning of the local committee the members of the society were brought together in a continuous series of social meetings—luncheons and dinner talks—and in inspection trips. The Dayton Engineers Club gave up its clubhouse to the visiting delegation as headquarters and in addition brought the early arrivals together in one of its regular meetings, when Paul M. Lincoln (Cleveland) in a talk on "Some Neglected Factors in the Sale of Electric Service" emphasized the importance of demand charging.

Inspections of the Taylorsville, Englewood and Huffman dams of the Miami Conservancy District and of the National Cash Register plant occupied Thursday. On Friday the Dayton channel improvement work was gone over, research work at McCook aviation field was examined, and an excursion was made to the Middletown plant of the American Rolling Mill Co.

President John R. Freeman opened the meeting with an interesting reference to an early period of flood study in the United States. He recalled James B. Francis' effort to provide, in connection with the Lowell canal, adequate protection of the city from the greatest flood ever to be expected, and his search throughout the valley for records of past floods. Francis found traces of a flood greater than any actually observed in historic times, and then built a flood-gate proportioned therefor. During twenty years this gate remained unused, but when the flood came the gates saved the city from inundation. This with other references to early work, and fine appreciation of the Miami Valley work, introduced the technical program, briefly summarized below.

Cloudburst Floods.—G. H. Matthes (U. S. Engineer's Office, Chattanooga) in one of the stimulating papers of the meetings, dealt with "Floods on Small Streams Caused by Rainfall of the Cloudburst Type." He pointed out the scarcity of data on the subject due to difficulties of observation and analysis in spite of the relative frequency of such floods, and asserted that cloudburst damage is probably the largest item of flood losses. Some specific records of very intense local precipitation included a rainfall of 7 in. in 90 min. at Cambridge, Ohio, and runoffs of 5.7 and 6 in. in 1½ and 2 hr. near York, Pa. That much more intense precipitation, amounting to the falling of water masses, may occur at small spots in cloudburst storms is indicated by scarring of the ground that has been observed repeatedly. The long record of Jones Falls floods at Baltimore was cited in support of the claim of frequency. Some localities seem to be specially subject to cloudbursts, others virtually immune. Plots of a considerable number of cloudbursts, in terms of second-feet runoff per square mile, establish a curve decreasing with increase of area from over 4,000 sec.-ft. for an area of less than 1 sq.mi. to 1,000 sec.-ft. for an area of 60 sq.mi. The author dealt also with control possibilities and the relation of cloud-bursts to the design of structures.

Closely parallel findings were reported independently by H. P. Eddy (Metcalf & Eddy, Boston) in a study of drainage areas. The old rule that a runoff of 6 in. in 24 hr. or 160 sec.-ft. per sq.mi. should be provided for in dam spillways is now known to be inadequate, he said, and in Pennsylvania many spillways are now being enlarged. While data on maximum runoffs in various regions of the country are scanty, so far as they go they seem to indicate that the relation between area and maximum runoff is the same for all parts of the United States. Fuller's method of estimation is found to be unsatisfactory in specific instances. The compilation of records by Mr. Eddy yielded a curve nearly the same as that shown by Mr. Matthes.

Cloudbursts are the chief source of Colorado floods, according to remarks of A. O. Ridgway (Denver & Rio Grande Ry., Denver) in discussion. East of the continental divide the average rainfall is less than on the west slope, but cloudbursts occur, while none occurs west of the divide. There are intense thunderstorms, often several in a group, often recurring, moving apparently without law. For data concerning them, the U. S. Weather Bureau records are entirely inadequate. The annual rainfall averages only 10 to 15 in. on the east slope, yet locally 10 to 14 in. have fallen in a single day, and 5 in. in 30 min.

Besides the irregularity and suddenness of cloudburst storms, factors meriting study are the coincidence of floods in neighboring tributaries, the influence of high flow velocities—often 18 to 20 ft. per min.—resulting

from the steepness of the country and the possibility of saving the flood-waters for irrigation use.

Floods in Canada and China.—Problems of flood control in the Red River and Winnipeg region were described by J. G. Sullivan (Winnipeg) in a paper on "Flood Conditions in Canada." These problems are complicated by their international aspect. Flood control in Minnesota and Dakota is closely related to that in the Canadian down-river region. Ultimately, co-operation between the states and Canada must be invoked, Mr. Sullivan suggested.

China's tremendous flood problems, particularly those of the Huai and the Yellow Rivers, were sketched by President John R. Freeman (Providence) in a richly illustrated address. With the river channels built up well above the delta plains and the soil fine and easily eroded, the task of holding the streams in flood time is great; yet by long experience the Chinese have developed an effective system of groin or spur-dike construction, in which a small amount of stone riprapping at the outer end protects the earth body of the groin from current erosion. A scientific development of the method is proposed by Mr. Freeman as the most available solution of the control problem.

Prof. D. W. Mead (Madison, Wis.) in discussion praised the ingenuity of the Chinese in their river work. They have proved that reeds and clay properly combined can do much. Yet in the long run their attempt to control the great rivers has been a failure, and this fact is attributable to their ignorance of the underlying science. One of the most advanced scientific men in China urged a project for Huai River control which included an outfall channel 200 x 10 ft., whereas flood-discharge calculations showed that a channel 2,000 x 20 ft. would be required.

The essential difference of the Chinese flood situation from any in America, as pointed out by A. P. Davis (U. S. Reclamation Service, Washington) is their much greater severity due to the extreme flatness of the country and the intensity of the rainfalls. One reliable record which he obtained was for 30-in. precipitation in one storm; another storm, in which the rain gage was swept away, is estimated at 36 in. These figures can not be held to be improbable, in view of still heavier rainfalls known to occur in the Philippines.

Great Flood Problems of the West.—In two papers of rather cyclopedic character certain of the great flood problems of the Rocky Mountain and Coast regions were treated. A. P. Davis dealt with "Relation of Flood Problems To Power and Irrigation Development in the Rocky Mountain Region." The Colorado River problem and the Boulder Canyon project were main elements of this paper. C. E. Grunsky (San Francisco) considered "Flood Prevention Methods on the Pacific Slope," a general review of the Sacramento-San Joaquin the White-Stuck-Puyallup, the Los Angeles and the Imperial Valley or Volcano Lake problems. Both authors stressed on the latter problem, and asserted that a final solution must be found soon if disaster to the Imperial Valley is to be forestalled. Mr. Grunsky said that the only agency to carry out the work is the United States, working in co-opeartion with the Mexican government.

Though most of the Reclamation Service dams were built solely for irrigation, Mr. Davis stated that they have proved of great value in flood reduction also. Thus, the Pathfinder Dam in 1909 saved a flood loss equal to the cost of the dam, and numerous other dams have done almost as much. In the case of Elephant Butte, one-sixth the capacity of the reservoir or about 400,000 acre-feet is reserved for flood control.

Mississippi River Control.—A valuable survey of the development of Mississippi River levee work was given by Past-President J. A. Ockerson (St. Louis) under the title "Methods of Flood Prevention in the Mississippi Valley." Its beginnings date back to 1717 at New Orleans and to 1818 at Baton Rouge. The great contested question in the early years of the Mississippi River Commission's work and prior levee building was whether levees raise the bed of the river; the contrary has been established that they lower it. The present standard (1919) levee of the commission has an 8-ft. wide crest 3 ft. above high water, and averages 18 ft. in height. Its yardage is about 422,000 per mile. The preceding or 1896 standard had a yardage of 104,000 and the 1882 standard a yardage of 31,500. At present 500 miles are up to standard, but the whole length of levee is up to normal flood height. Mattress protection was described as an important feature, covering willow, articulated concrete and solid concrete sheets.

Miami Conservancy Work Reviewed.—With the approaching completion of the Miami Valley flood-protection work, special interest attached to addresses by Arthur E. Morgan and Charles H. Paul, the former and present chief engineers of the project, describing its planning and construction. Mr. Morgan discussed factors of the work that ordinarily receive only passing consideration but that are as vital as the technical items of design and construction. Thus, concerning proper provision for employees, "If your concrete inspector's wife has indigestion," he suggested, "so that he worries about her and is inattentive to his job, the results may be just as harmful to the work as a fault in design." Accordingly, care for the well-being and satisfaction of the working organization was part of the theme of the address. More important, however, were such matters as the strategy and diplomacy needed to secure the purposeful co-operation of the local people; the volunteer financing of the preliminary investigations; the patience required for deliberate planning of the project and passage of enabling legislation, in the face of a public desire to see dirt fly within three months; development of fundamental data (on rainfall, flow, benefits and the like); and existing prejudices against reservoir control. Mr. Morgan in sketching the early course of the work paid glowing tribute to Col. E. A. Deeds, afterwards a director of the district, for his part in raising the subscription fund that made possible the sound development of the project—the District itself was not formed until 3 years later and obtained no money until 4½ years after the flood—as well as for his fight against the many discouragements and obstacles that threatened the work.

Mr. Paul briefly outlined the project as developed, and the manner of carrying through its construction, as detailed in past issues of *Engineering News-Record*.

An interesting sequel to these addresses was an intimate talk given by Col. Deeds at a society smoker on April 7, under the title "Human Phases of the Miami Conservancy Project," in which he recounted in graphic style the way in which the almost insuperable difficulties that beset the work throughout the 4½-year period up to the start of construction were overcome. Characterizing the occasion of the address as the valedictory of

the Conservancy District, he expressed his deep regret that the finest group of men ever assembled, the engineering and construction staff, will now be scattered again. There will be no tablets of names on the structures of the District; "the work is greater than any one man."

Standing Waves.—Four types of standing wave were described by N. C. Grover (Geological Survey, Washington) under the title of "Standing Waves in Rivers." They are: (1) The hydraulic jump, a wave facing upstream and fixed in position, which is represented in most roughnesses of water surfaces except those due to wind and falls; (2) sand waves, moving surface waves corresponding to moving masses on the bottom; (3) tidal bores; and (4) the standing flood-wave, or the "wall of water" at the front of a flood mass.

Community planning in relation to flood-protective measures was touched on in a brief paper by Morris Knowles (Pittsburgh). He referred to the river-bank development at Harrisburg and the levee drive at Sunbury, Pa., as instances of how several purposes may be joined in one construction, and outlined some possibilities in this direction in the proposed Pittsburgh flood work. Two other short papers, by J. B. Challies (Ottawa) and George M. Lehman (Harrisburg) were passed without reading.

Missouri River "current retards" composed of trees held by cables to deeply submerged anchor piles were described by Roy N. Towl (Omaha). Building up of eroding banks has been accomplished successfully by these retards, which are in effect permeable groins.

J. Albert Holmes (Boston) reported test data on hydraulic-fill core material from the Paddy Creek and Linville dams. Seepage and compression tests were made, whose results, Mr. Holmes said, supply assurance as to the safety of hydraulic-fill dams supplementing that given by C. H. Paul's recent paper on hydraulic-fill cores.

Expansion Coefficients of Some Metals

Recent measurements of the expansion of nickel, monel metal, stellite, stainless steel, and aluminum made at the Bureau of Standards have just been published by the Bureau (Scientific Paper 426). These measurements were carried through the region from 0 to 600 and 900 deg. C. Stainless steel (steel containing about 13 per cent chromium) is the only one of these metals whose expansion curve departed much from a straight line; this material has a sharply defined irregularity of large range between about 800 and 855 deg. C. Nickel was found to have a coefficient of expansion in a range of moderate temperatures (below that of boiling water) of about 13 one millionths per degree, which is 10 to 20 per cent greater than that of steel, and considerably greater than those of most porcelains. In the range from 300 to 600 deg. C., the coefficient rises to about 16½ one-millionths. Monel metal had closely similar values, about 14 for the range from 25 to 100 deg., and 17½ one-millionths for the range from 300 to 600. Various samples of stellite (an alloy of cobalt, chromium and tungsten, sometimes with iron) ranged from 11 to 15½ units for the lower range to 14.7 to 18 units for the higher range. Stainless steels showed a coefficient of about 10 units in the lower range and 13½ in the upper range. Aluminum showed an expansion coefficient of about 23½ below 100 deg., and about 36 one-millionths in the neighborhood of 600 deg. C.

Comparative Merits of Stadia and Plane Table for Mapping

Topographic Work in Rough Alabama Country Necessitates Quick, Accurate, Method—Stadia Believed Best

By Ray Crow
Assistant Chief Engineer, Land Department, Tennessee Coal, Iron and Railroad Company

SOME TWO years ago the Tennessee Coal, Iron and R.R. Co. began the topographical mapping of portions of its coal and iron ore lands in the Birmingham district of Alabama. This information was desired by various departments of the company for use in making studies for and projecting future developments.

The work came under the direction of the land department, George Macatee, chief engineer, and it fell to the writer to develop a system of field work for the purpose. The areas being mapped out are for the most part very rough and broken and practically covered by a thick growth of timber and underbrush. Much of the ground is an eroded plateau cut by numerous geological faults which give many peculiar twists and turns to the drainage. The streams, mostly small, run tortuously in narrow steepsided canyons intercepted with frequent side ravines. The high ground thus is a series of long, irregular, main ridges between the larger streams, with secondary spurs separating the ravines. The timber varies from second growth pine thickets to virgin forest.

The irregularity of the ground, together with the foliage, usually limits the length of vision to from 50 to 200 ft. A transit shot of as much as 400 ft. is exceptional without heavy clearing. It is necessary to use field parties of nine or ten men each as this mapping is a fill-in job and the men are subject to call for other classes of work.

Considering the conditions cited the method to be adopted required thought and experiment. The system tried first embodied the use of the transit and stadia, with the recorder using a drafting board mounted on a tripod on which he platted the shots as the length, azimuth and vertical angle were observed and called to him by the instrumentman. He then sketched in the main drainage features and the contours. However, to use a field party of nine or ten men efficiently it is necessary to keep four or five rodmen busy. With the short distance each had to walk between shots the recorder could not do this and keep up with the sketching. Also, with so many short shots—it is not unusual for the instrument to occupy fifty to seventy stations per day—an occasional error in vertical angle or azimuth was unavoidable and when found by closure or tie to some point on the control, replatting and resketching of possibly an entire day's work was necessary.

For these reasons this method was abandoned and the use of a plane table considered. It was evident, however, that the latter would only partially overcome the dificulties mentioned, and would present additional disadvantages. An alidade sliding on a table would be more unwieldy in searching out a road through natural openings in the foliage than a transit telescope. The table would be cumbersome to carry, set up, and orient. Vertical angles as high as 45 deg. are not uncommon and it would be difficult to read these and keep the straightedge on the platted point. More time would be lost in moving around a plane table when taking

side shots at rough set-ups then around a transit. Moreover, none of the instrumentmen available had even seen a plane table, but then were more or less expert with a transit.

The entire area under consideration had been carefully surveyed by the company as the land was purchased, and permanent monuments had been set at all government section corners and at property subdivision corners. All roads, fences and principal streams had been meandered and the few buildings and other landmarks noted. Each section had been accurately platted to a scale of 500 ft. to the inch, showing this information.

This land survey was taken as the control for the topographic mapping system finally decided upon, and the section was made the unit. Each section plat is carefully copied on a field sheet 16 in. x 20 in. and furnished to the chief of the field party. The stadia party (consisting of the instrumentman, recorder, four rodmen and two or more axemen), start a stadia traverse from a corner or some mapped point in the section and cover the area as closely as necessary, taking notes in the usual way. All instrument stations are marked with hubs and guard stakes. Each rodman carries an axe and when he gives a sideshot he blazes the nearest tree on the side toward the instrument and marks the number of the shot on the blaze with crayon. The traverse lines are usually run approximately parallel to the north and south sides of the section and as often as convenient ties are made to mapped points, or the traverse is closed.

Preceding the stadia work a line of bench marks is established along the alternate east and west section lines with a wye-level. Levels are checked at the end of each two miles of traverse. In the evening the traverse line is platted to the tie or closure of the day, and if the error of closure is small it is corrected then and the adjusted traverse transferred to the field sheet. Any large error is corrected by checking field notes, or if necessary rereading azimuths in the field. The side shots are then platted, elevations are reduced by stadia slide rule and noted on the map in correct location by a dot with number of shot above and elevation below a short line extending from the dot toward the instrument station from which the shot was taken.

When the entire section is completed in this way the topographer pins the field sheet to a light drafting board, goes into the field and follows the traverse from station to station. At each he orients the board and sketches in the contours, drainage features and other information, in so far as the control from that station will permit. Any additional points that may be thought necessary are located by pocket compass, pacing and hand level from the marked points on the ground. The field sheet becomes the original map and all information is retained on it, including location of traverse lines, number and elevation of instrument stations, side shots, etc. However, when tracings are made for reproduction, which are in sheets showing areas two miles wide and six miles long, only the contours and improvements are shown.

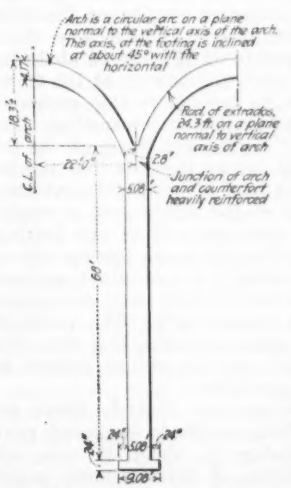
To date about eighty sections have been mapped. The accuracy of the completed work has been tested in many cases and found to be sufficiently close for all required purposes. Quantities estimated from profiles taken off these sheets have checked within 2 per cent of those figured from profiles run on the ground.

LETTERS TO THE EDITOR

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

How Should We Figure Foundation Pressures in a Multiple-Arch Dam?

Sir—In a recent engineering argument the foundation pressures in a dam about to be built and the stresses in the structure incident thereto were the subject of violent difference of opinion. In view of the fact that all the principal parties to the argument were rated as engineers well versed in structures, it would appear that certain of us are woefully ignorant of something that we ought to know with the utmost certainty. A difference of opinion concerning matters of judgment is entirely permissible; a difference of design theory of such degree as to represent in the one case safety, and in the other, extreme hazard, if not absolute failure, is absolutely without excuse, and should not be possible within the profession. It is with the hope of obtaining from such of your readers as are qualified to give them, expressions concerning the proper determination of foundation pressures in general, and with regard to a special type of structure in particular, that I am led to open a discussion of the matter.


Arch is a circular arc on a plane normal to the vertical axis of the arch. This axis, at the footing is inclined at about 45° with the horizontal
Rad. of extrados, 84.3 ft. on a plane normal to vertical axis of arch
C.L. of arch
22'-0"
2.8'
Junction of arch and counterfort heavily reinforced
69'
24'
24'
24'
90.0'

FOOTING OF 80-FT. MULTIPLE-ARCH DAM

Stated broadly, the question involved is simply this: Given a structure of any sort and shape whatever, the various parts of which have footings terminating at the same foundation plane, and in which these parts are so tied together and so rigid that the structure necessarily responds to stress and deformation as a unit. What is the foundation area? Is it the sum of the area of the footings of all of its parts, or is it the sum of only one or more of these areas? If one of the structural members is of much greater bulk than the others, with a correspondingly larger footing area, and carrying the greater part of the vertical load on the structure, is that any reason for assuming that all of the foundation pressure or reaction is carried by the footing of this member, leaving the other footings to sustain no pressure whatever? If the other footings do sustain pressure, then in what amount and how distributed? Are we to use our "judgment" and our idea as to what "looks reasonable" in solving this question, or shall we consider the structure as a unit, the foundation area as a whole, and then solve the problem by the application of the established principles of mechanics applicable thereto?

The above questions are purposely put in the general form. Applied to the particular case which was the subject of the argument previously mentioned, let us consider a multiple-arch dam. For the purpose of this discussion the structure may be said to be of the usual type, the arches being securely and rigidly attached to the face of the abutment, and carried down to the same foundation plane and material as the abutment. The arches are of such mass and are so secured that there is presumably no possibility of any vertical movement of the arch with respect to the abutment. There is no perceptible line of

demarkation between the arch footing and the abutment footing, the one simply merging into the other. For the purpose of determining foundation pressure, what is the foundation area of the structure? That of the abutment alone, or that of the abutment plus that of the half arches attached to it?

The designer of this dam, who is an engineer of considerable prominence and repute, claimed that the foundation area was that of the abutment alone, and on this basis, together with the magnitude and position of the resultant force, which *included the entire weight of the arches*, he showed a maximum pressure at the toe of about 8 tons per square foot and a minumum pressure at the heel of about 6 tons. This accounted for the whole vertical load, so that under the arch footing immediately adjacent to the heel of the abutment footing, continuous and integral therewith and divided only by an imaginary line, there was shown to be no pressure whatever. It appears to me that under a rigid and continuous footing, such an abrupt change in the distribution of foundation pressures is absolutely inconceivable and that any theory or method which gives such results is necessarily an absurdity.

In my analysis to determine the foundation pressures which the proposed structure would develop, I considered the abutment and the two half arches attached thereto, as a unit, together with all the forces acting thereon. The position and magnitude of my resultant was in virtual agreement with that of the designer. The foundation area I took to be the sum of the footing areas of the half arches and the abutment. I found the center of gravity of this area and its moment of inertia, also the moment of the resultant about the center of gravity of the area. I then applied the well known formula, $f = P/A \pm Mc/I$, which gave a maximum pressure at the toe of abutment of about 19 tons per square foot, and tension at the crown of arch footing of about one ton per square foot, assuming that the structure would take tension in the footing. The great difference between my results and those of the designer is of course accounted for by the fact that the inclusion of the arch footing as part of the foundation area, moves the center of gravity of the whole area a considerable distance toward the upstream end of the footing, as compared with the center of the abutment footing proper, and results in a large eccentricity of the resultant, as compared with what this would be if taken about the center of gravity of the abutment footing only. The resultant remaining fixed in direction and magnitude, this eccentricity is, of course, one of the most important factors in determining the foundation pressure.

The particular foundation pressure analysis above referred to, in which the different methods employed gave maximum compressions differing by about 11 tons per square foot, applies to a section of the maximum height of 80 ft. The situation becomes increasingly critical as the height diminishes, since, while the area of the abutment footing decreases rapidly, the area of the arch footing decreases very slowly, resulting in the continual movement of the center of gravity of the whole area toward the heel of the abutment, and the consequent increase of eccentricity of load unless the resultant also moves forward correspondingly, which in the case of this particular dam it did not. It would appear then that, considering both safety and economy of design, it is scarcely permissible that such divergent theories should be held and applied by different, but presumable responsible, members of the profession of engineering.

In conclusion, the writer wishes to state that he has had available a fair assortment of text-books which purport to treat more or less fully on the subject of foundation pressures in general and particular. He has investigated these works most carefully in an effort to find a direct and authoritative discussion of the point at issue, and has found almost nothing. The nearest approach to the thing sought was found on p. 532 of the American Civil Engineers Pocket Book, which, by analogy, the writer believes substantiates his position. With this one exception, the authors all discussed foundation pressures as applied to a rectangular footing area pertaining to a mass structure of simple and regular foundation plan. It is not remarkable if some engineers have formed the habit of thinking that a foundation area must necessarily be rectangular in order that the pressures thereon be capable of determination; that the only formula for this purpose is the usual one in the form of $f = P/L(1 \pm 6e/L)$; and that the only criterion of safety is the "rule of the middle third." If our text-book writers would occasionally bring out the fact that the preceding formula is only a special and simplified form of the general equation, $f = P/A \pm Mc/I$, as applied to a rectangular area of pressure, I believe that the general understanding of the principles of foundation design would be greatly improved.

It would afford me pleasure to sign my name at the bottom of this, but the injection of personality is not called for by the purpose of this discussion, and for various reasons it is desirable that just at this time there be given no publicity concerning the relation between this discussion and a certain proposed structure. Consequently, I sign myself. ENQUIRER.

Anywhere, March 14.

Economics of Narrow-Gage Railways

Sir—So much has been said of the burden imposed on transport by the transfer of freight between railways of different gages that the main reason for narrow-gage lines has been obscured. That main reason is the economy in construction and operation. Freight transfer is only one of several factors which must be weighted in arriving at a decision. Where a considerable part of the movement will probably originate or terminate on a connecting line, the gage of the latter would determine that of the new line. The question of gage has been considered too much from the viewpoint of a national or continental transportation unit, which may not be justified where the transportation needs of a region must be considered mainly on the basis of the topography and probable economic development of that particular region.

Such cases are encountered occasionally in this country, but in the southern hemispheres they are numerous. For example, Argentina offers many points which indicate faulty decision. About 1909 the province of Buenos Aires adopted a policy of fostering the construction of light meter-gage railways between the lines of the larger broad-gage systems. But in this prairie district the difference in first cost was negligible, curvature was not a factor and any intermediate lines would speedily develop a greater traffic than could be handled economically on a narrow-gage line.

In the narrow-gage railways, both state and private, in the northern part of Argentina, all factors at the time of development indicated the superiority of narrow-gage construction. Although an unlooked-for turn in the development of the country has brought forward the consideration of dense, long haul traffic and freight transfer, these questions are not paramount. These narrow-gage lines, grouped about the Central Cordoba Ry., should have brought their export-import haul to navigable water near Parana instead of carrying it over the Central Cordoba trunk line to Buenos Aires. But the necessary coordination, including river and harbor work, is difficult to accomplish. In spite of this wrongly imposed burden of long dense-traffic haul, for which narrow-gage lines are uneconomical, it is doubtful if its cost approaches the saving effected by narrow-gage operation throughout the rest of the system where light tonnage prevails.

In the west coast countries conditions warrant narrow gage roads, if we accept low cost per ton mile as the criterion. It is true, however, that there are standard-gage lines of considerable tonnage in successful operation. In most cases the problem has been to supply transportation from an interior valley to the nearest navigable water and this has resulted in a succession of small units each serving a territory which can never develop a great volume of traffic, and quite or nearly independent of intercommunication with contiguous units. Here it is obvious that the

lighter the tonnage, the greater becomes the proportion of fixed charge to total cost of transportation, so that a saving of 10 per cent in construction cost may effect a 20 per cent saving in total transportation cost.

The saving in construction cost due to reduction of cross-sectional area is small, but in mountainous country the difference between curves of 21 and 14 deg., comparable on meter-gage and standard-gage, respectively, may mean the difference between a comparatively light cut and a tunnel, or a choice between a feasible line and one that is financially impossible. Another reason for the narrow gage is that many such small lines hold no hope of being commercially profitable. The government, believing their construction necessary to the development of the country, may grant financial assistance, but would not feel justified in incurring the extra cost for a line which could never be used to full capacity. This attitude, based on economic conditions, has become in some cases a clearly defined policy, as in the Chilean government's adoption of the meter gage on all new development since 1908. C. C. MUHS.

Chicago, March 20, 1922.

Possible Full-Size Dam Tests at Boulder Canyon

Sir—The writer was impressed by the ingenious method discussed in *Engineering News-Record*, Feb. 2, p. 184 by Arthur P. Davis for constructing a rock-fill dam at the Boulder Canyon site, by blasting huge masses of rock from the high cliffs on both sides of the canyon.

However, such an undertaking would be so far beyond any precedent both with regard to size of structure as well as to method of construction that undoubtedly it would be viewed with great concern by many engineers. The writer is informed that the rock of those canyon walls, when blasted, is liable to break rather into small pieces than into large blocks. This process might be intensified to a rather undesirable degree by the material dropping for a height of several hundred feet from the cliffs above the crest of the dam onto the first layers at the water level or slightly above it. Thus, local accumulations of comparatively fine material might lead to rather annoying consequences, as it is the intention to build the diversion tunnels only large enough to carry the low flow and moderate floods of the river, and to take the excess waters of big floods over the dam. Assuming such excess waters at about one-tenth of the annual run-off, a quantity of nearly two million acre feet of water would then pass the first year over and through the unfinished dam. The danger from blow-outs in the rock-fill placed during the year preceding the flood would therefore appear to be so imminent that unquestionably a very liberal allowance would have to be made in the cost estimates for such contingencies. The critical time, of course, would be when the dam had reached a height of from 50 to 150 ft. above river bed, and before the reservoir capacity thus created were large enough to store the flood peaks.

The construction of a masonry dam would seem to involve far less risks than the building of a dam of the rock-fill type as discussed above. If it is possible to build a thin arch diversion dam upon the foundation rock, as Mr. Davis suggests, and it may be found necessary to build farther downstream a similar structure, but arched in opposite direction to keep off the back-water, the excavation for the main dam and the construction of the dam itself would appear to be a comparatively simple matter. Also the diversion tunnels, which for the rock-fill dam would have to be at least three-quarters of a mile long, could then be perhaps less than one-third as long. Consequently, at the same cost they could be excavated for a masonry dam about three times as large in cross section than for a dam of the rock-fill type, and this would bring them probably close within the size necessary to divert also floods of considerable magnitude. By building further the arch diversion dam for 20 or 30 ft. higher than the structure discussed by Mr. Davis, sufficient head could be created upon the enlarged tunnels to divert also the maximum flood flow of 200,000 sec.ft.

If such a masonry dam were selected for the Boulder Canyon site, and constructed by the aid of an arch diversion dam, as suggested by Mr. Davis, the writer believes that this would be an excellent opportunity for making numerous tests and experiments on this arch dam and stressing it ultimately to virtual destruction after it had done its useful work for diversion purposes.

In order to enable such tests to be made, the main dam would have to be built a short distance below the arch diversion dam in such a manner that a free space of a few feet were left between the up-stream side of the main dam and the downstream side of the arch. As soon as the main structure had been built to a safe height above the arch dam, systematic experiments could be started on the arch by regulating the flow through the diversion tunnels in such a manner as to obtain any desired head of water in front of the arch dam.

By equipping both the big dam and the small arch dam with valves which would permit to fill or to empty at will the narrow space between the two structures, a large range of varying loads, acting upon the arch dam, could be obtained. For instance, by putting the arch dam under full pressure, measuring its deflection, stresses, etc., then filling the space between the two dams with water, which, of course, would have the effect of releasing the arch entirely from pressure, and then taking new measurements, most valuable results could be obtained. Such experiments might be repeated several times a day and thus furnish excellent checks.

By using high unit stresses from the beginning and raising the arch subsequently in a very slender cross section, it might be possible to increase the water pressure such as to make actual failure imminent. It would not be necessary to let the arches really break through, because the very instant that stress and deflection measurements would show that the elastic limit of the arch material had been reached, water could be let to flow into the narrow space between the two dams, thus relieving the arches almost immediately from dangerous pressure. Thus, it would be possible to conduct over a period of a year or more, and without interfering with the construction of the main dam, such "full-size" tests on the arch diversion dam, by relying for safety on the "big brother" back of it.

It is the understanding of the writer that the alternately proposed masonry dam at the Boulder Canyon site is of the gravity type. It is entirely possible that such tests as suggested above might furnish sufficient data to warrant after their completion, that the upper part of the main dam be continued in the shape of an arch. The cost of the experiments might thus pay for themselves manyfold by the large saving which undoubtedly would result by changing the upper few hundred feet from a gravity to an arch section. Furthermore, the space between the main structure and the arched diversion dam could be filled out with concrete after the tests had been completed, and the two structures securely tied together to act as an enlarged gravity base and as a perfect support for the upper arching part of the main dam.

The enormous benefits which would be gained by such "full-size" test (the arched diversion dam would be from 175 to 200 ft. high) for future dam constructions, are evident. They would most probably lead both to greater economy and increased safety of future similar structures, and they might possibly prevent that the engineering profession has to learn the real statical conditions and the ultimate strength of arch dams by an actual failure with all the distressing consequences incidental to the destruction of a large storage dam.

The writer hopes that the Boulder Canyon dam is going to be built in the near future, and that the dam selected will be a masonry structure. It would appear that the construction program outlined by Mr. Davis for a masonry dam, perhaps with some slight modifications as further investigations may develop, will lead to a safe and economical solution of the problem of the Colorado River.

San Francisco, Calif., March 10, 1922.

FRED A. NOETZLI,
Chief Engineer,
Beckman and Linden Engineering Corp.

NEWS OF THE WEEK

New York, April 13, 1922

Review Construction Status at Federation Meeting

Hoover Speaks on Trade Associations —Program Fails to Attract Representative Attendance

Despite the hard work of its president, E. T. Trigg, and its general secretary, W. S. Hays, the fifth annual meeting of the National Federation of Construction Industries, held in Chicago last week, proved to be a disappointing affair. It had been announced as a National Construction Conference, and though the subjects outlined and the papers introducing them were worthy of an imposing meeting there were lacking the attendance and enthusiasm necessary if the conference was to have any influence on the construction situation. It is true that the presidents or other prominent officials of various organizations within the construction industry were present, but they alone made only a small conference group and could not carry a meeting which had been given the high-sounding title of "National Construction Conference." The total registration remained below 200, and at none of the meetings did the attendance exceed that figure.

The whole purpose of the program was to inquire as to what could be done to revive construction through a cheapening of construction costs. The various methods for cheapening costs, such as simplification and standardization of building materials, the training of apprentices in order to secure an adequate supply of competent construction labor, the work of the Architects Small-House Service Bureau, the various activities of the Department of Labor, the effects of transportation, building codes, financing methods, etc., were all covered in excellent papers.

Hoover's Address

Chief among the addresses was that by the Secretary of Commerce, Herbert Hoover, in which he laid emphasis upon the service to industry and to the country which could be performed by trade associations through the elimination of waste. He pointed out that it was far better to work out these problems by private initiative through trade associations than through the "patent medicines of government interference." Speaking of the influence of labor on construction costs, he remarked:

"There can be no answer to the fundamental fact that the standard of living of all the people is the simple quotient of the commodities and services we produce. The more we cheapen the production of a commodity, the larger the number of people who can obtain it. Restriction upon effort in the building trades simply reserves the better class of buildings and of homes to the better-to-do fraction of our people. At present costs it is scarcely possible for a worker from his own income to build a new and ample home. We want a nation of home owners. There are more buildings needed and in position to fin-

(continued on p. 629)

Kansas City Votes $11,000,000 Water Bonds

A water bond issue of $11,000,000 was carried by a 4 to 1 popular vote at an election in Kansas City, Mo., on April 4. These bonds had an actual, but not necessary, two-thirds majority at an election held Nov. 22, 1921. On the latter date a bi-partisan water commission of four men was chosen with power to build new works. This commission will supplant the existing Fire and Water Board as regards the Water Department only. The commission has as members one engineer, Alexander Maitland, Jr., president of the Kansas City Bridge Company; a wholesale jeweler and former mayor of Kansas City, George H. Edwards; a clothing merchant and a real estate man.

Detailed plans for the proposed new works have not yet been made, but it is expected that they will follow in general outline the recommendations of a report made in 1920 by Fuller & McClintock, New York City, and reviewed with recommendations for certain modifications by a board of local engineers of which W. Kiersted was chairman (see *Engineering News-Record*, Oct. 28, 1920, p. 865).

According to the report mentioned the choice of the new works was between building an entirely new intake, pumping and filtration plant in Clay County, Mo., and a new and somewhat similar plant at the present Quindaro station on the Kansas side of the Missouri River.

Trial of Cement Makers on Criminal Charge Begins

Attempt to Prove Trade Restraint and Price Control Begun in Federal Court of New York

The trial of forty-four individuals and nineteen corporations engaged, at the time of indictment a year ago, in the manufacture of cement in the Lehigh district, began last week in the federal court for the southern district of New York, before Judge Knox. The charge against the cement makers is a violation of the Sherman anti-trust law—the charge imputing the existence of a conspiracy to control prices through the general interchange of price and trade information.

The government will base its case largely on proceedings recorded in minutes books of the defendant corporations and the association of firms now known as the Cement Manufacturers' Protective Association. The government charges that there was a conspiracy inferred in minutes of meetings, correspondence, etc., in and between companies and that in the Eastern district there was no competition in the manufacture and sale of portland cement. The government will also aim to prove price control through curbing of production below actual demand.

(continued on p. 630)

Submit New Plan for Use of Narrows Tunnel

Propose Combined Rapid Transit and Freight Service between Staten Island and Brooklyn

Following the rejection by the executives of the trunk-line railroads entering New York of the city plan for a terminal railroad system keyed to the proposed Narrows tunnel, the special committee of the Board of Estimate and Apportionment having the matter in hand has submitted to that body new plans and recommendations concerning the project.

It is now proposed to build a combined freight and rapid-transit passenger railroad connecting Brooklyn and Staten Island by means of a two-tube tunnel designed to accommodate the largest freight and passenger cars that enter the metropolitan district. In Brooklyn a rapid-transit terminal is to be provided in the vicinity of Fourth Ave. and Bay Ridge Parkway, convenient to the existing Fourth Ave. subway, and a freight terminal is to be located between Sixth and Seventh Aves. adjacent to the Long Island R. R. On Staten Island both freight and passenger terminals are to be located at Arlington, and a freight connection is to be made to the new city piers at Stapleton. Intermediate passenger stations are to be provided at St. George and at other points.

Features of Project

The entire project consists of a tunnel about 5.5 miles long from portal to portal and an extension of about 3.6 miles on Staten Island, which for the most part will be on embankment, thereby avoiding grade crossings. These figures do not include the several spurs and connections. The tunnel will have a maximum grade of 2 per cent and within the harbor line will not project above a plane 50 ft. below mean low water.

It is estimated that the project, exclusive of rolling stock, will cost not to exceed $60,000,000 and will require until the summer of 1929 to complete. It is recommended that the subaqueous section of the tunnel, about 2 miles in length, with its two shafts, be put in hand at once and that for this purpose and for the acquisition of the lands necessary for the remainder of the line $27,000,000 be made available. From time to time further appropriations will be required which will amount to the total of $60,000,000 by 1927. Estimates have been based on the shield method of construction, although the trench method will be considered as an alternative provided the consent of the War Department can be obtained.

The committee reports an opinion of the corporation counsel that, although the city has the right to construct this line, it lacks the power to operate it, and intimates that such power should be obtained by the city before the completion of the railroad.

A.A.E. Nominates Three Candidates for President

Three fields of engineering are covered by the experience of the three candidates for president of the American Association of Engineers; the election results will be announced at the annual convention to be held in Salt Lake City, Utah, June 5-7. A. M. Van Auken, consulting engineer of Chicago, has been identified with railroad engineering during the most of his professional career. A. N. Johnson, at present dean, Engineering College, University of Maryland, is closely associated with highway engineering, and Clarence W. Hubbell, consulting engineer of Detroit, has specialized in municipal engineering problems.

Something new in the announcement of candidates for technical society offices are the platforms which each of these three men have enunciated. Excerpts from these platforms are given below.

Mr. Van Auken began his engineering experience with the Union Pacific R.R. in 1883 and he followed that class of work almost continuously until his association with Harold Almert as consulting engineer, Chicago. He has served on various engineering committees. He was the first vice-president of the Chicago chapter, A.A.E., and secretary of the Nashville, Tenn., chapter in 1920. He is the chairman of the educational committee of the Chicago chapter.

Mr. Johnson, after his graduation from Harvard University in 1894, became an instructor at that institution. Positions which he has held include the office of state highway engineer of Maryland, chief engineer of the U. S. Bureau of Public Roads, state highway engineer of Illinois, consulting engineer for the Bureau of Municipal Research, New York City, and consulting engineer for the Portland Cement Association. He was the first vice-president of the A.A.E. and has been most active in its committee work.

Previous to his graduation from the University of Michigan in 1893 Mr. Hubbell had been on railroad location and construction work. Five years after his graduation he served as civil engineer to the board of water commissioners of the City of Detroit, a position which he held for nine years. In 1909 he was made city engineer of Manila, P. I., and in the next year became chief engineer of the Bureau of Public Works of the Philippine Islands. In 1917 he was appointed city engineer of Detroit, a position he held until his recent entrance into the consulting field.

A. M. Van Auken — "Thirty-nine years of engineering experience, working in thirty-five states, in railroad, irrigation, mining, river and harbor, municipal and building engineering, has given me an insight into the aspirations, resentment and yearning of the junior engineer. Long a student of economics, it has been my privilege to advise in law making. Long associated with reform bodies has given the privilege of aiding and remedying abuses. I feel that my training fits me to serve you. Should you select me as your president, I will serve you with loyalty."

A. N. Johnson— "My ideal of A.A.E. is: To advance the engineering profession that it may render ever greater service for the public good; to promote the welfare of the engineer that he may be of greater worth to himself and his profession; to secure the active aid of all organizations of engineers and to render them generous help in every worthy endeavor; to imbue each member of the American Association of Engineers with a spirit of service to his fellows and to his community; and always to make him sensible of his responsibility to live and impart the ideals of the American citizen."

Clarence W. Hubbell — "Ethics! Of course, we must have them and live them. They keep us from being savages.

"Education! Yes. He who does not master some branch of his chosen profession is not worthy to be a member of that profession. But always it is not to be found in universities and learning is a poor substitute for common sense.

"Get your job. Deliver the goods. Collect your money. Live your life. These four things every man must do. To help each member of the engineering profession to do them well is the true aim of the Association."

Engineer Carries Suit for Pay to U. S. Supreme Court

Engineering work performed by E. Kirby-Smith for the International Lumber and Development Co. is involved in a case before the U. S. Supreme Court. The case is an appeal from the Circuit Court of Appeals, which reversed the first decision of the District Court.

Mr. Kirby-Smith is a Tennessee engineer, who developed the lumber company's plantations in Mexico for six years beginning in 1905. He worked under contract of Markley & Miller, employing 500 to 2,500 men, clearing the tropical forest and planting 20,000 acres in henequen, rubber and bananas. When he left on account of ill-health Markley & Miller owed Mr. Kirby-Smith $105,000 for which they gave him notes and drafts on the lumber company. Only one draft, for $4,000, was paid by the company, payments on the others being refused, whereupon Mr. Kirby-Smith sued.

The District Court awarded him judgment in a first trial but ruled against his claim on a second, which was affirmed by the Circuit Court. From this decree Mr. Kirby-Smith has appealed to the Supreme Court.

Department of Justice Asks Increased Appropriation

In asking for an increase from $100,000 to $300,000 in its funds for investigating violations of the anti-trust laws, officials of the Department of Justice told the House appropriations committee that the department was much behind in this work, there being 157 pending cases. The Department has 27 attorneys engaged in anti-trust prosecutions, six of whom are in New York in connection with the building investigation. Pending anti-trust cases are against tile, ceramic and cement combinations, including a combination of cement manufacturers operating from Denver.

Am. Soc. C. E. Has 10,275 Members

According to its latest *Year Book*, the American Society of Civil Engineers on Feb. 10, 1922, had 10,275 members distributed among the following grades: Honorary members, 6; members, 4,479; associate members, 5,164; affiliates, 164; juniors, 452; fellows, 10. The foregoing total compares with 9,884 members on Feb. 10, 1921.

California Supreme Court Reaffirms Antioch Decision

The Supreme Court of the State of California on March 22 reaffirmed its decision of last year dissolving the temporary injunction of a lower court that was issued to prevent irrigators along the Sacramento River from diverting water from that stream.

This suit, which is known as the "Antioch case" and which was reported in *Engineering News-Record*, Oct. 27, 1921, p. 697, has attracted widespread interest because of the precedent which it would establish. The San Francisco city attorney attended the hearing as amicus curiae and filed a brief on behalf of the city because of the possible effect on the Hetch Hetchy project of the outcome of the case.

Reaffirmation by the Supreme Court means that irrigationists along the river will divert all the water they require, pending the trial of the suit itself. Thus far the hearings have had to do only with question of granting the temporary injunction forbidding water diversions.

No date has been set for trial of the suit on the legality of the diversions themselves.

House Bill Provides Two-Year Road Program

Appropriations of $65,000,000 and $75,000,000 Planned—Federal Participation $12,500 per Mile

(Washington Correspondence)

After nearly a month of intensive consideration of the highway situation the Committee on Roads of the House of Representatives came to the conclusion that it would be better to provide at this time for two-year program only. As a consequence, the committee has placed upon the calendar of the House the Dunn bill appropriating $65,000,000 for federal aid during the next fiscal year and $75,000,000 for the fiscal year to end June 30, 1924. The main reason influencing most members of the committee to provide a two-year program only was the hope that financial conditions would be better later and that it would be possible to appropriate $100,000,000 for the third year. The bill also carries $6,500,000 for forest roads and trails during the fiscal year to end June 30, 1924.

The new bill is so worded as to leave no doubt as to the intention of the federal government to participate in underpass as well as overhead construction in the elimination of railroad crossings at grade.

LIMIT OF $12,500 PER MILE

State highway officials generally are pleased with the provision in the new bill which limits federal participation to $12,500 per mile during the next fiscal year and $10,000 per mile thereafter. The position of the committee is that road construction exceeding $20,000 or $25,000 per mile is almost entirely in sections of congested traffic where the localities are amply able to contribute more than one-half of the cost of construction.

Heretofore when federal money would be allocated to a definite project it would remain idefinitely to the credit to that particular piece of construction. In case the project were abandoned, the money was lost to the state. The new bill allows this money to be allocated to another project.

A clause covering fraud, with penalty of 5 years imprisonment or $10,000 fine, or both is included in the bill.

The bill makes it mandatory for a state to put a project under contract within one year. Provision also is made for the extension, for five years, of the time in which Texas, Arkansas and other states may change their constitution to comply with the Federal-Aid Act.

More War Material for Roads

Large quantities of surplus war material which was so helpful to many of the states in road construction last season are still being distributed to state highway departments by the U. S. Bureau of Public Roads. Recently there has become available for distribution 5,000,000 board feet of lumber and material valued at $220,000 consisting of steam and gas engines and machine shop equipment, none of which has been used. Most of the lumber was intended by the army for the construction of a pier at Charleston, S. C. and will be suitable for highway bridges. The machinery and equipment are stored at the Picatinny Arsenal, Dover, Del.

Buffalo Section Endorses Loweth, Not Coleman

In *Engineering News-Record*, March 30, p. 544, it was stated that the Buffalo Section of the American Society of Civil Engineers had endorsed the name of John F. Coleman for the presidency. This was an error. Up until the time that note was written no action by the section had been taken, but on April 5 a resolution was passed endorsing the candidacy of C. F. Loweth.

Canadian Road Builders Select Victoria For Convention

Announcement is made by the executive committee of the Canadian Good Roads Association that the ninth annual convention will be held June 13-16, 1922, at the Empress Hotel, Victoria, B. C. In the program particular attention will be given to the experience gained during two years of federal aid.

Statistics collected by the Dominion authorities show that up to Sept. 30, 1921, approximately 50 per cent of the federal appropriation of $20,000,000 had been absorbed. Eight provinces had participated (Alberta being the exception), and in all 126 projects had been undertaken, representing a total of about 3,800 miles and an estimated total expenditure of $24,000,000, with 40 per cent of this sum being drawn from the Dominion grant.

Other subjects to be discussed at the convention include cost data, highway financing, economical methods of improving earth roads, and greater attention to maintenance.

International Engineering Congress in Rio Planned

It is probable that an international engineering congress will be held at Rio de Janeiro in connection with the centennial exposition which is to start there next September to celebrate the 100th anniversary of the independence of Brazil. Under the direction of the Club de Engenharia de Rio de Janeiro preparations are now being made for the congress, and it is understood that representative engineers from all American countries will attend the congress.

The principal subjects of discussion as now outlined are: The utilization of fuel resources, the best utilization of water power, recent advances in irrigation methods, the elimination of waste through the standardization of supplies for agricultural and industrial purposes, coal as a factor in industrial development, essentials of a national railroad policy, intercontinental engineering cooperation, port developments, terminal facilities, and steel industry.

As the first step of American participation in this congress, it is announced from Washington that the Bureau of Public Roads is to have an exhibit at the exposition which it is expected will stimulate trade in American-made road machinery and motor vehicles. Models showing various steps in the construction of roads, colored transparencies and motion pictures will be used to illustrate American methods of road building. Manufacturers of road machinery and equipment are invited to supply small-scale models, literature, and motion pictures if desired.

Further action on the international engineering congress is expected from the national engineering societies.

Live Water-Works Program for Philadelphia Convention

The tentative program for the American Water-Works Association convention at Philadelphia, May 14 to 19 has many features that promise to give life to the convention. Besides the general sessions at which a variety of papers and committee reports will be presented, the Manufacturers Water Works Association will have the floor one evening, the superintendents will have a whole day, and the chemical bacteriological section will have two afternoons and also a joint forenoon session with the other members of the association.

On May 14 provision has been made for "group meetings" in the forenoon and afternoon. In the evening the president's address will be followed by a reception and dance. Among the papers on Tuesday will be one by George W. Fuller on the "Philadelphia Water Supply, Present and Proposed" and another by F. C. Jordan, on "Fire Prevention and Fire Protection in Relation to Public Water Supply." In the afternoon of the same day the development of the Schoharie watershed, Catskill water supply, New York City, will be taken up by J. Waldo Smith, the Hetch Hetchy water supply for San Francisco by M. M. O'Shaughnessy, the construction of the Loch Raven dam, Baltimore, by William A. Megraw, and twenty years of filtration practice at Albany, N. Y., by G. E. Willcomb. Prof. John H. Gregory will speak on a subject not yet announced.

Later on during the convention there will be moving pictures showing steam control by the Dean system, and lantern slides illustrating the casting of iron pipes centrifugally. Wood pipe will be discussed by J. W. Ledoux, causes of failure of cast-iron pipe by F. A. McInnes, control of tastes and odors in water by W. W. Brush, water softening by Prof. Edward Bartow and G. C. Baker, and chlorination by Dr. Frank E. Hale and others.

The convention will be held at the Bellevue-Stratford, Philadelphia. The secretary of the association is J. M. Diven, 153 West 71st St., New York City.

F. K. Zook Resigns After 47 Years With One Railroad

After completing 51 years of railroad service, 47 of which were spent on the California system now known as the Northwestern Pacific, F. K. Zook has resigned.

Mr. Zook was graduated from the Polytechnic College of Pennsylvania in 1871 and immediately joined the engineering staff of the Painesville & Youngstown R.R. In March, 1875, he became assistant engineer of the Sonoma-Marin R.R., one of the several lines which were consolidated and extended to form the present Northwestern Pacific system. He was soon made chief engineer of that line and throughout the succeeding years continued to direct the engineering work of the system as it grew to larger proportions. From time to time he also filled executive positions, some of which were assistant superintendent, superintendent and general superintendent.

From 1919 to the date of his retirement he was valuation engineer for the company.

Review Construction Status

(*continued from p. 626*)

ance themselves than there are skilled workers to build them if we could reduce the costs of building. Any justification of those employers opposed to organized labor would disappear at once if labor used its organization to promote the best effort of its members."

In conclusion he again addressed himself to the subject of trade associations in the following words:

"This brings me again to trade associations themselves, whether of manufacturers, distributors or workers. I believe in them. They are a complete necessity in our growing economic life. They can and have been mis-used. They can make for stability and economy in industry and for public welfare. Their two greatest fields of usefulness lie in the lifting of moral standards in these trades and in the increased efficiency of our production and distribution."

Miscellaneous

Many of the matters covered by the convention would not be new to readers of *Engineering News-Record*, such as the various activities of the Department of Commerce in simplification, building codes, and zoning ordinances. Much emphasis was given to the need for building up a satisfactory system of apprenticeship in the building trades, an excellent paper on the subject having been sent by Hugh Frayne, general organizer of the American Federation of Labor. The subject recurred several times during the conference, showing that contractors would probably be willing to do their part in the working out of a satisfactory apprenticeship system.

Adding to the interest of the meeting were a number of exhibits showing the work that had been done in standardization of different building materials, such as floor and wall tile, common and paving brick, slate, lighting fixtures, elevators, and wall paper.

The following new directors were elected: D. Knickerbacker Boyd, architect, Philadelphia; E. J. Russell, architect, St. Louis; F. W. Walker, of the Tile Manufacturers' Association, Beaver Falls, Pa.

The following officers were re-elected: Vice-presidents, Gen. R. C. Marshall, Jr., general manager, Associated General Contractors, Washington; B. F. Affleck, president, Universal Portland Cement Co., Chicago; treasurer, A. M. Maddock, president, Thomas Maddock's Sons Co., Trenton; directors, Rudolph P. Miller, former superintendent of buildings, Borough of Manhattan, New York; Charles W. Brown, president, Pittsburg Plate Glass Co., Pittsburg; Charles S. Keith, president, Central Coal and Coke Co., Kansas City, Mo.

New York To Develop Barge Canal Water Power

Governor Miller has signed the Robinson bill which appropriates $1,000,000 to be expended in building water-power plants at the Crescent and Vischers Ferry dams on the New York State Barge Canal, where approximately 10,000 hp. may be developed. The bill provides for the ownership of the plants by the state and the sale of surplus power over the small amounts required to operate the canal to the highest bidder.

Consolidate British Railways as Step in New Grouping

(*London Correspondence*)

The first big consolidation under the British railways-grouping scheme has taken place in the amalgamation of the Midland and the London & North Western companies which are being absorbed as from Jan. 1, 1923, into a new company. For the remainder of this year the two roads will work in close co-operation in order to facilitate the actual consolidation. The London & North Western serves London and the northwestern counties, including the cities of Rugby, Birmingham, Derby, Sheffield, Crewe, Manchester, Liverpool, Leeds and Carlisle. The Midland Ry. serves most of these cities together with the city of Lincoln. The capital of the L. & N. W. amounts to £188,292,156 and that of the Midland to £203,894,659.

Plan to Extend Tumalo Project

Bonds to the extent of $550,000 have been voted and validated by the courts for the extension of the facilities for irrigating land in the Tumalo Irrigation District in Oregon. The plan includes the extension of the present feed canal with a capacity of 250 sec.-ft. from Tumalo Creek about 5 miles to the Deschutes River near Bend, and to store 30,000 acre-ft. water at some point on the upper Deschutes River.

The Tumalo Irrigation District comprises 26,500 acres, of which 15,000 acres are irrigable, exclusive of about 1,000 acres in the old Tumalo reservoir which was constructed by the state but never used because of leaks which developed soon after construction. If these leaks cannot be stopped by sluicing, land within the reservoir will also be irrigated. About 7,800 acres of the irrigable land in the district now have party water-connecting rights.

Reconstructed Waterloo Station Opened to Traffic

Reconstruction of the Waterloo station, London terminus of the London & Southwestern Ry., commenced in 1900, has recently been completed and the new station formally opened to traffic by Queen Mary.

The first section of the new station was completed in 1912. Since then the project has been carried on continuously although much hampered by the war. All the work has been conducted without interruption to traffic, which, it is estimated, consists of about 1,200 trains entering and leaving the station daily. One of the entrances from York Road has been designed to form a memorial to the employees of the company who fell in the war. The completed station, regarded as the most extensive and best arranged railway terminus in the country, occupies a total area of 24½ acres of which 10 acres are roofed in. Subway passages provide for direct access to the Underground railways and for the handling of parcels traffic.

The reconstruction was designed and carried out under the direction of the chief engineer of the company, a position which was occupied until the early part of 1914 by the late Mr. J. G. Jacomb Hood, and since that time by Mr. W. A. Szlumper. Mr. R. D. Hawes has been resident engineer throughout.

Live Topics Before Illinois Section, Am. W. W. A.

Fire Engines Favored—Tastes and Odors, Iron Removal—Meter Reading and Billing

Like the Indiana Sanitary and Water Supply Association and the Iowa Section of the American Water Works Association, the Illinois Section of the last named society at its annual meeting March 29 and 30 went on record as opposed to raising the water pressure for every fire turned in. Calling for a gradual increase in the use of pumpers the resolution followed a discussion of a paper on "Co-ordination of Water and Fire Departments" by Clarence Goldsmith, assistant chief engineer, National Board of Fire Underwriters, who stated that he was in hearty sympathy with the idea if a sufficient pressure, night and day, were maintained normally. Since the high cost of operation has existed it appears that many plants have materially dropped night pressures to save fuel. Mr. Goldsmith felt that sprinkler systems should always be under a head.

Particular interest centered in round-table discussions on tastes and odors, iron removal, records and accounting.

Tastes and Odors

Howard M. Ely, superintendent, Danville Water Co., outlined his experience with a novel aerator wherein the water falls onto a perforated cone-shaped distributor on which are angle baffles. He has not yet had sufficient experience to judge of the efficacy of the aerators to remove tastes and odors due to microorganisms. H. F. Ferguson, chief engineer, Illinois State Board of Health, instanced a case of a dangerous, polluted well supply being substituted for a public supply because of objectionable though innocuous algae growth in the latter. R. E. Greenfield, chemist of the Illinois Water Survey, asked that the superintendents send to the Water Survey or State Board of Health data on the use of copper sulphate to destroy growth and chlorine gas, odors.

Office Records—W. E. Lautz, superintendent, Pekin water-works, led the discussion on office records and accounting which followed a paper on "Collections" by E. McDonald, superintendent, Lincoln Water & Light Co. Strong tendencies were noted toward systems which keep a few meter readers and bill clerks busy continuously rather than a large number rushed at the end-of-the-month periods. Mr. McDonald has put water, gas and electricity bills of each customer on one sheet of paper.

Iron Removal—A hundred supplies have trouble from iron, said Dr. A. M. Buswell, chief of the State Water Survey. W. A. Hutchins, Freeport, stated that a treatment with 2 gr. per gallon of lime followed by filtration had been used successfully for 20 years but the sand cemented together and had to be removed at intervals. Recently the lime dose has been omitted and the quality of adsorption of the precipitated iron in the surface of the filters left after incomplete washing was made use of to take out the colloidal iron. The use of extremely small quantities of clay to adsorb the iron and to prevent the precipitation from sticking to the sand is to be tried at Freeport.

Henry Ringness was elected chairman and G. C. Habermeyer secretary.

Colorado Wants Interstate Stream Priorities Protected

Amendment of the Reclamation Act and the Water Power Act to recognize the principle of equitable division of interstate waters, particularly those of the Colorado River, among the states involved is called for in a recent report to the Denver Civic and Commercial Association by a committee on interstate streams. L. G. Carpenter, consulting hydraulic engineer was a member of the committee. The recommendations in the report have been adopted by the association and support of Colorado's congressmen is to be enlisted.

The report recites various difficulties which have been encountered in Colorado in the past when the federal government has refused to grant rights of way over federal lands which would permit diversions for use of new projects within the state, from the headquarters of the North Platte feeding the Pathfinder Reservoir and the Rio Grande feeding the Elephant Butte Reservoir. Colorado wants to divert without subsequent interference some of the Colorado River water through the range for use of Denver and the vicinity. The amendment to the Reclamation and Power Acts recommended would provide specificially that no water project constructed by the government and taking its supply from an interstate stream should constitute a priority of right in respect to later diversions and applications of water from the same source in other states.

Trial of Cement Makers Begins

(*continued from p. 626*)

Roger Shale, Special Assistant U. S. Attorney General, opened the case for the government, sketching the history of cement manufacturing in this country and the importance of the product as a construction material. He asserted the government would endeavor to prove there had been no competition among manufacturers for years.

Col. Henry L. Stimson, of counsel for the defendants, asserted that competition and not co-operation among cement makers had been responsible for the apparent similarity of prices within certain producing districts. Four points on which the defense will make its case are: (1) that government investigators have found competition most keen among cement manufacturers; (2) that profits, according to federal statistics, have been extremely low—a return on invested capital of 7 per cent in 1919 and 5 per cent in 1920; (3) that during post-war price inflation cement prices rose much less than the average of other commodities; and (4) that the Portland Cement Association and the Cement Manufacturers' Protective Association existed not as agencies to stifle but to make more intelligent the competition among manufacturers through a widespread dissemination of statistics on production, stocks and shipments.

The defense will endeavor to show there is ample cause for the existence of identical prices for a product which must conform to certain standards as to constituent materials, strength, quality, etc., and that cement requires such large facilities for storage and handling that the best merchandising is found through dealers, which fact further tends toward uniformity in price.

New Committee for Bridge Over The Hooghly at Calcutta

Numerous plans for a long bridge with drawspan over the Hooghly River at Howrah, just above Calcultta, India, were submitted to a committee some months ago, but the committee arrived at the conclusion that a drawspan of sufficient width for ocean steamers was unnecessary. A new committee has been appointed by the government to investigate the situation and to recommend the type of bridge best suited to the conditions. This committee includes J. Coates, city engineer of Calcutta, and J. McGlashan, chief engineer of the Calcutta Port Commission.

Civil Service Examinations

UNITED STATES

For the United States civil service examinations listed below apply to the United States Civil Service Commission, Washington, D. C., or to any local office of the Civil Service Commission.

Vacancies in the General Land Office Service.

Transitman, $120 to $150 a month and subsistence while in the field. Examinations will be held May 10.

Vacancies in the Patent Office.

Assistant Examiner, $1,500 a year plus bonus of $20 a month, granted by Congress. Examinations will be held May 10, 11 and 12 and June 21, 22 and 23.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Meeting, Atlantic City, May 9-11.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Convention, Philadelphia, May 15-19.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago; Annual Convention, Salt Lake City, Utah, June 5-7.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; Annual Convention, Portsmouth, N. H., June 21-22.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, University of Pittsburgh; Annual Convention, University of Illinois, June 20-23.

The North Carolina Chapter, A. A. E. elected the following officers at its annual meeting: President, W. S. Fallis; vice-president, Harry Tucker; secretary-treasurer, H. K. Witherspoon.

The Buffalo Section, Am. Soc. C. E. has elected the following officers for the year: President, Walter McCulloh; vice-president, Alfred Spire; secretary-treasurer, John H. Feigel.

The Engineering Council of Utah held its annual banquet at the Hotel Utah, March 27 having Herbert C. Hoover and other members of the Colorado River Commission as guests.

The Arkansas Chapter, A. A. E., held its March meeting at Bauxite, lunching at the club house of the American Bauxite Co. and making a tour of the mines and plant during the afternoon.

The Wisconsin County Highway Commissioners' Association elected the following officers at its recent meeting: President, Andred Eklund; vice-president, William Hoenig; secretary-treasurer, E. Gleason.

The St. Joseph Chapter, A. A. E., elected the following officers at its recent annual meeting: President, Clayton O. Judson; 1st vice-president, A. C. Lingley; second vice-president, J. R. Leslie; secretary-treasurer, H. J. Gish.

The Utah Agricultural College Chapter, A. A. E., was recently established at Logan, Utah. Officers elected were: W. H. Willesen, president; W. T. Cannon, vice-president; and H. E. Dalton, secretary-treasurer.

The Washington Post of the Society of American Military Engineers had as its principal speakers at its recent meeting held at the engineer reproduction plant in Washington, Col. John Stewart, president of the post, Major-General Lansing H. Beach, Chief of Engineers, and Major W. W. Kirby, Director of the reproduction plant. Major Kirby gave a talk on the importance of maps in war. Throughout the evening the plant was in full operation and upon completion of the lecture the audience divided into groups and inspected each department whose chiefs explained in detail the various operations and processes. More than 250 members of the post and their guests attended the meeting.

The San Francisco Section, Am. Soc. C. E. on March 24 conducted an excursion to the new pumping and filtration plant now under construction for the city of Sacramento, Cal. The party of about thirty members visited the plant under the leadership of Charles Gilman Hyde, consulting engineer on the work. A series of pipe tests conducted by the California Concrete Pipe Manufacturers' Association was also witnessed.

PERSONAL NOTES

F. LAVIS has recently returned to New York from Bolivia where he has been engaged as consulting engineer to the Bolivian Government and the Ulen Contracting Corp. in connection with railway projects including the line from Atoche to La Quiaca.

HARVEY FULLER, city engineer of Chatham, Ont., has been appointed city manager. He will continue to act as city engineer.

GEORGE H. ROWE, assistant engineer of the board of public utilities of Los Angeles, Cal., has been appointed assistant engineer with the California State Road Commission. He was formerly instructor in engineering at Leland Stanford Jr. University and at the Colorado School of Mines.

GUY C. MCGEE and CHAS. B. SMITH have opened offices in Boise, Idaho, for the practice of engineering, specializing in irrigation, drainage and municipal projects. Both have been identified with this class of engineering work in the West for many years.

L. O. MARDEN, formerly bridge engineer for the state highway commission, Bismarck, N. D., has been appointed engineer for the Worcester Consolidated St. Ry. Co., Milford, Attleboro & Woonsocket St. Ry. Co., Interstate Consolidated St. Ry. Co. and the Attleboro Branch Ry. Co., with headquarters at Worcester, Mass.

ROBERT WINKLER, for 21 years director of the technical service of the Swiss Federal Railways, has retired because of ill health. He was vice-president of the Swiss section of the permanent commission which organized the Berne International Railway Congress in 1910.

FRANK D. DANIELSON, formerly assistant manager of Glencoe, Ill., has been appointed village manager of Hinsdale, Ill.

HORACE BOYOTT, for three years engineer of Brazos County, Tex., has resigned to become assistant engineer of Jefferson County with headquarters at Beaumont, Tex.

DAVID B. MILLER has been appointed city engineer of Michigan City, Ind., succeeding D. C. FORD, who retired to enter private practice.

JAMES C. ADAMS, deputy city engineer of Binghamton, N. Y., has resigned to become consulting engineer for Stento & Serifina, contractors, Binghamton, N. Y.

M. C. ERWIN, sanitary engineer of the state bureau of sanitary engineering, Tex., has resigned to become city engineer and sanitarian of Port Arthur, Tex.

THOMAS COLIN, superintendent of the water department at Caledonia, N. Y., has resigned to engage in business for himself.

H. L. ALBERT, civil engineer, Green Bay, Wis., has been appointed city engineer of Seymour, Wis.

H. R. F. HELLAND, who entered an engineering partnership with his father in San Antonio early this year, has been made assistant sanitary engineer for the State Board of Health, Tex.

W. W. HARMON has been appointed city engineer and ex-officio superintendent of streets of Oakland, Cal., succeeding George Mattis.

BUSINESS NOTES

THE CHAIN BELT CO., Milwaukee, Wis., has announced the appointment of G. F. Sherratt as manager of the Pittsburgh office.

A. W. BOWIE and J. J. LYDON, connected for the last twenty-five years with Westinghouse, Church, Kerr & Co. and Dwight P. Robinson & Co., their successors, have resigned and organized the construction firm of Bowie, Lydon & Co., with offices in Chicago. Mr. Bowie has been in charge of the design and construction of shops, office buildings and power plants for the Missouri Pacific Ry. Co., Crane Co., The Armour Leather Co. and others. Mr. Lydon superintended the construction of the Government nitrate plant at Muscle Shoals, embarkation camps Stuart and Hill, and various facilities at Newport News. W. G. BIERD, president of the Chicago & Alton R.R. Co., has accepted the presidency of the new organization.

HENRY S. DAY, engineer of equipment, Kansas City Ry. Co., has been made vice-president in charge of production of Smith & Sons Manufacturing Co., builders of road machinery. Previous to the war he was with Sanderson & Porter.

E. D. BARSTOW, sanitary engineer, and G. E. MCCURDY, former manager of the Akron branch of the Morris Knowles Engineering Co., Inc., have formed an engineering partnership with offices in Akron.

THE DRESSER-MINTON CO., construction engineers, has been organized in Cleveland, Ohio, by F. J. C. Dresser and J. H. Minton. Mr. Dresser had been with the Chicago & Northwestern for a number of years, and also with the Pennsylvania and New York Central Railroads in charge of construction. Mr. Winton was formerly senior assistant engineer in the office of the chief engineer of construction, Pennsylvania Lines West.

ALFRED C. ANDERSON and GEORGE A. SPOONER have formed a partnership for the practice of engineering and architecture under the firm name of Anderson and Spooner, with offices at Council Bluffs, Iowa.

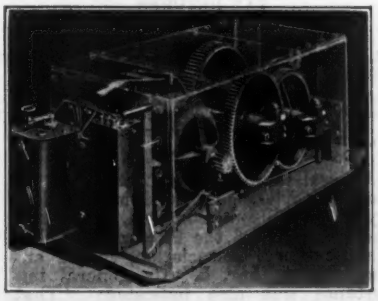
PERRY K. MILLER and CROSBY J. MCMIFFERT have opened an office in Montclair, N. J., for the practice of civil engineering. Both Mr. Miller and Mr. McGiffert had been connected with the engineering department of the town of Montclair for several years.

THE KOEHRING CO. OF CANADA, LTD., has been organized in Toronto to handle Koehring mixers, pavers, cranes, and other construction and industrial-plant equipment.

EQUIPMENT AND MATERIALS

A Self-Contained Small Hoist

A self-contained, portable hoist different from small hoists heretofore available has been developed by the Treadwell Engineering Co. of Easton, Pa. This hoist is wholly enclosed in a steel casing, mounted on a ½-in. steel

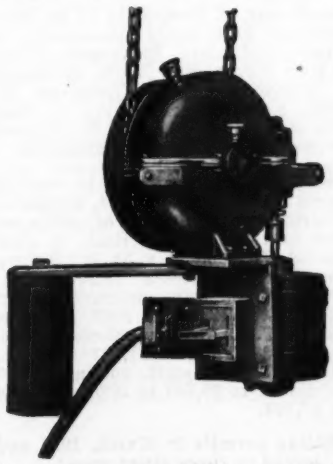


sole plate. The unit casting forms the support for the drums and gear-shaft bearing which are steel castings fitted with renewable bronze bushings and lubricated from a waste-packed oil reservoir.

The controller box and resistance panel are mounted on the exterior of the casing. All other mechanism and the motor are entirely enclosed. The hoist has a clutch manipulated by a lever at the operator's end of the hoist. Control of the load is effected by a powerful band brake whose controlling hand-lever is normally latched in an "off" position, allowing the hoist drum to run free. A removable door or cover is provided on the top of the casing to give easy access to the mechanism within. The 8 x 12-in. drum has a capacity of 1,500 ft. of ⅝-in. wire rope and the rated hoisting capacity of 1,500 lb. at a speed of 100 ft. per minute. The motor is 5 hp., operating at 1,200 r.p.m. The hoist measures 2 x 2 x 4 ft. 5 in. over all.

Motor for Operating Hand Hoists

A motor which can be hung in the bight of the operating chain of a hand hoist and which will overhaul 138 ft. of chain per minute and furnish a chain pull of 130 lb. has been put on the market by the New Jersey Foundry & Machine Co., New York City. The ap-



pliance gives a load-lifting speed approximately four times that obtainable by handpower and requires but one man for operation. Current may be supplied by a flexible conductor connected to convenient sockets or suspended from the hoist if it is more desirable to bring the feeders to that point. The machine balance itself, weighs about 160 lb. and is easily handled.

Out-of-the-Ordinary Trade Publications

A 500-page book of views and brief descriptions of reinforced-concrete structures has been published under the title of "Hennebique Ferro-Concrete" by L. G. MOUCHEL & PARTNERS, 38 Victoria St. London, England. The volume is a valuable one for students and others interested in knowing the variety of uses made in Europe of reinforced concrete.

Cacium chloride as a material for laying dust on gravel roads and for delaying frost action, and is a curing agent on concrete road construction is discussed in "How to Maintain Roads" published by the DOW CHEMICAL CO., Midland, Mich.

Cast-iron pipe and fittings are catalogued in a 125-page leather bound book published by the LYNCHBURG FOUNDRY CO., Lynchburg, Va.

Business Side of Construction

Facts and Events that Affect Cost and Volume

Rapid-Fire Survey of Business Conditions

Common labor on road work averaged 28c. per hour for the entire country in February, according to the Bureau of Public Roads of the Department of Agriculture. The range was 13@20c. in the South, 25@30c. in the Middle West, and 45c. in the Pacific States. Teams without drivers ranged from 24@42c. per hour.

Common labor on all construction averaged 43c. per hour for the United States in both February and March, according to *News-Record* reports. The range was 15@30c. in the South, 47½@62½c. on the Coast, 40@72½c. in the Middle West, 35@75c. in the East. Highest rates are in New York and Chicago.

Retail cost of food, Feb. 15 to Mar. 15, declined as follows: Manchester, 4 per cent; Baltimore, Bridgeport, Newark, New Haven, New York, Richmond and Washington, 3; Milwaukee, 2; Denver, 1. The decline over the last twelve months ranges from 26 per cent in Denver to 51 per cent in Richmond.

Cost to build a residence is over 70 per cent higher than in 1914, according to Charles Cason, director of public relations of the Chemical Bank of New York. A 7-room, 30 x 34 ft., 2-story frame house, contents 29,100 cu.ft., floor area 2,640 sq.ft., costing $5,529 in 1914, rose to $12,815 in 1920, and now costs $9,502. A 2-story colonial house, 8 rooms (2 attic rooms), 23 x 41 ft., 25,315 cu.ft., 2,530 sq.ft., costing $4,176 in 1914, rose to $9,767 in 1920, and now costs $7,374.

Building permits in March, 1921 and 1922, issued in three cities were:

	March Number 1922	1921	March Value 1922	1921
Columbus....	622	520	$1,294,500	$971,910
Los Angeles..	4,241	2,911	10,864,829	6,915,216
Tacoma.....	401	444	301,431	361,935

27,839 apartments are under construction in New York, according to the Tenement House Commission. The number of rooms is 107,054; the cost, $120,462,500.

Immigration aggregated 226,841 from July 1, 1921, to Feb. 28, 1922; emigration, 152,649. Following are some of the figures:

Race or People	Immigrant	Emigrant
English	19,301	6,349
French	8,536	2,046
German	21,409	3,798
Hebrew	41,689	516
Irish	10,363	1,561
Italian (north)	5,747	6,365
Italian (south)	33,776	37,301
Scandanavian	9,789	2,888

Bank Business totaled $9,166,000,000 in the week ending April 5, which was 16 per cent greater than the preceding week or the same week of 1921. This can be accounted for partly by end-of-month and end-of-quarter settlements effected March 31.

Steel production for March totaled 2,370,751 tons of ingots, which is at the rate of 33,787,400 tons per year, or 64.3 per cent capacity. February production was at 47.2 per cent.

Foreign exchange active, with sterling at $4.41 and the Canadian dollar nearly 98 cents.

Bond issues offered to investors in the New York market this week aggregated $111,912,500, the largest week's total since the first part of March, according to the *Times*. The continued ease of the money markets and the strength of old bonds in the open market turned the attention of investors to the new securities, and, practically without exception, they were fully subscribed, investment brokers reported. The bonds were divided into the following groups:

State and municipal	$10,757,800
Foreign	23,700,000
Public utility	14,955,000
Railroad	60,000,000
Land Bank	2,500,000
Total	$111,912,500

The largest single issue was of $60,000,000 refunding and improvement mortgage 5s. of the New York Central Railroad Company, offered by a banking syndicate at 94½, to yield approximately 5.30 per cent. The bonds mature in 91 years and are redeemable as a whole, but not in part, after Oct. 1, 1951, at 105. Bankers reported, when the books closed, that there had been about three applicants for every bond. Allotments were made on a 30 per cent basis, and trading in the bonds, on a when-issued basis, has been at a slight advance over their offering price.

Largest tax-paying States of the country were Illinois, Massachusetts, New York, Ohio and Pennsylvania paying 60 per cent of the total corporation tax of the United States in 1916; 63.3 per cent in 1917; 63.7 per cent in 1918. The same five States paid in 1916 personal taxes amounting to 72.2 per cent of the total personal tax of the country; 66.6 per cert in 1917 and 63.2 per cent in 1918 (Nat. Lumber Mfrs.' Assn.).

PERCENTAGE OF TOTAL UNITED STATES TAX RETURNS

	Corporation Tax			Personal Income Tax		
	1916	1917	1918	1916	1917	1918
Ill....	8.74	10.23	8.82	6.31	7.02	7.50
Mass.	5.21	6.40	8.68	6.28	6.47	7.20
N. Y..	25.88	18.42	25.56	44.96	36.96	31.40
Ohio..	7.20	10.18	8.46	4.45	4.59	4.89
Penn..	12.97	18.10	12.19	10.16	11.53	12.22
Total	60.00	63.33	63.71	72.16	66.57	63.21

Federal taxation is a problem of utmost importance to the lumber industry said Wilson Compton, Secretary and Manager of the National Lumber Manufacturers Association, in his annual report, Apr. 5. Its general importance was also indicated: "That this problem is not yet solved is apparent when the citizens of five states, having less than one-third of the representation in Congress and one-tenth of the total vote in the Senate, pay two-thirds of the Government's revenue from taxation. It can be expected that the incentive to economy in Federal expenditures will be inadequate, and will so continue until the sources of Federal revenue by taxation are more widely diffused. As long as the representatives in Congress of forty-three states, whose citizens pay but little of the taxes, can commit the Government to expensive enterprise, and send the bill to the five states which pay the bulk of the taxes, it can scarcely be expected that men, willing to experiment with other people's money but not with their own, can be pushed away from the Government bargain counter."

Bituminous prices averaged $2.06 per ton at the mines for the week of Apr. 3, which is 71 per cent higher than before the war, according to "Coal Age."

Painting Trade in Chicago on Non-Union Basis

Refusal of the painter's union in Chicago to accept the required wage cut and eliminate certain unfair and arbitrary restrictions indicated by Judge Landis has resulted in that trade being declared open shop by the Citizens Committee to Enforce the Landis Award. The painters had a contract to March 31 which the committee did not disturb until expiration. About 600 men struck and are being replaced by painters furnished by the committee.

Eleven trades comprising 6,600 craftsmen are now operated under non-union conditions. Nearly one-half are carpenters, with the number of laborers, sheet metal workers, plumbers and painters following in the order named.

Nearly 650 jobs valued at $30,500,000 are going ahead under the Landis award and building is progressing as expeditiously as at any time in the last five years. Some remarkable results have been accomplished according to T. E. Donnelley, president of the citizens committee. There has been no graft. Any man can undertake to get a building done on time and be assured that there will be no stoppage.

Opportunities for Steel Sales in Canada

A considerable amount of new construction which would involve the use of steel is being contemplated by the Canadian government according to a recent report to the Department of Commerce by the vice-consul at Quebec. The chief engineer and director of railways of the Province of Quebec has stated that for 1922 a substantial number of new bridge projects are being planned. Cost of the 55 bridges now under construction totals in excess of $1,000,000. Seven bridges are to be built this season. The steel necessary to build them aggregates 3,500 tons.

Only two railway projects are planned for this year. The first, which is under construction, is a 70-mile colonization road of the Interprovincial and James Bay Ry. The second is the Quebec-Chibougamou Ry. through Lake St. John. This will be a first class road using a 100-lb. rail.

Production and Materials Stocks in Ten Cities

Increased Steel and Lumber Output—Quick Mill Shipments of Steel—Lumber Demand 5 Per Cent Above Normal

Steel—The present annual rate of steel ingot production is estimated at 33,000,000 tons as compared with a rate of 29,000,000 tons, one month ago. Production now stands around 70 per cent of capacity and represents a rate somewhat higher than the average tonnage rate for either 1912 or 1913, the two best pre-war years for steel tonnage. Production is particularly heavy in steel pipe, tin plates, sheets and wire nails and has practically tripled in the last nine months. The coal strike and replenishment of stocks probably serve as the two principal factors in determining the present increase in steel output. Pig iron production is estimated at a rate of 25,000,000 tons per year, at the present time, or over 50 per cent greater than production in 1921.

Cement—Production of portland cement for the month of February, 1922, according to the United States Geological Survey, amounted to 4,278,000 bbl. as against 4,379,000 bbl. in February, 1921. Cement shipments, however, reached a total of 3,285,000 bbl. for February, 1922, as compared with 3,331,000 bbl. for the same month in 1921. Stocks on hand for the entire country, at the end of the month totaled 14,310,000 bbl. for February, 1922, while 11,400,000 bbl. represented the total reserve for the same period in 1921.

Brick—Information as of Mar. 1 received from the Common Brick Manufacturers Association shows only 83,900,000 burned brick on hand as against 237,980 000 on Feb. 1, 1922, and only fifty plants closed down as compared with fifty-eight inactive during the month preceding. The quantity of unburned brick on hand indicates that the plants being operated are piling up stock preparatory to an active season; the labor situation throughout the country being favorable. In the Chicago district which is the largest brick producing center in the world, the deliveries of brick throughout the months of February and March were at a rate that promises a season's output closer to normal than has been experienced in the past two years. In other large centers the demand is above normal for this season of the year.

REPORT ON COMMON BRICK FROM 108 YARDS AS OF MARCH 1, 1922.

Dist. No.	Including States of	No. of firms reporting	Plants Closed down	Burned Brick on Hand	Orders on Books	Price Per Thousand at Brickyard	Price Per Thousand at Brickyard Feb. 1, 1922
1.	N. Y., New England	11	10	4,160,000	3,983,000	$11.00 to $20.00	$11.00 to $20.00
2.	Pa., N. J., Md., D. C., Del.	12	3	3,950,000	32,438,000	12.00 to 17.00	12.50 to 17.00
3.	Va., N.C., S.C., Ga., Fla	6	2	1,314,000	1,334,000	10.00 to 16.00	10.00 to 16.00
4.	Mich., Ohio, W. Va.	11	6	4,957,000	7,915,000	10.00 to 16.00	10.00 to 16.00
5.	Ill., Ind., Wis	29	9	59,474,000	109,230,000	11.00 to 17.00	11.00 to 17.00
6.	Ky., Tenn., Miss., Ala., Ark., La.	11	4	4,577,000	3,699,000	8.00 to 14.00	8.00 to 14.00
7.	N. and S. Dak., Minn., Neb., Ia., Kan., Mo.	8	7	220,000	428,000	10.50 to 17.00	12.00 to 17.00
8.	Okla., Tex., N. M.	8	6	579,000	2,136,000	8.00 to 14.00	7.50 to 14.00
9.	Wash., Ore., Mont., Wyo., Ida., Utah, Col.	8	3	783,000	76,000	10.00 to 17.50	12.00 to 18.00
10.	Calif., Ariz., Nev.	3	0	3,886,000	5,755,000	14.00 to 15.00	14.00 to 15.00
	Total	108	50	83,900,000	166,994,000		

Lumber—An average of 382 mills reporting weekly to the National Lumber Manufacturers Association for the month ending Mar. 25, shows 720,744,348 ft. cut; 743,469,637 ft. shipped and orders for 780,201,616 ft. b.m. as compared with 683 385,486 ft. cut; 660,939,476 ft. shipped and orders for 671,747,145 ft. during February, 1922. Production for the week ending Apr. 1 stands at 20 per cent and shipments at 10 per cent below normal. Lumber demand throughout the country has reached 5 per cent above normal—as compared with 43 per cent below normal for the week ending Dec. 31, 1921.

New York—Demand for basic building materials unusually heavy in March. Steel, brick, lumber, sand, gravel, crushed stone and hollow tile all shipped into New York by water. Slowness of deliveries from manufacturers to dealers, in some of the important materials, threatens to prevent warehouses from keeping sufficiently stocked, in excess of demand, to meet the increasing seasonal building activities. Brick demand exceptionally heavy. A total of over 16,000,000 Hudson River common brick shipped into the New York market during the week ending Mar. 31, were all sold out by the following day.

Minneapolis — Lumber stocks are fairly well assorted but small; about 75 per cent of normal in this trade territory (Minnesota, the Dakotas and eastern Montana) and 90 per cent of normal in the Twin City District. Brick stocks are normal but lower than a year ago.

Los Angeles—Plenty of sand, gravel, cement, brick and sewer pipe; not on the market for yellow pine, spruce, paving block and paving stone.

Cincinnati—Hard lumber on hand for 100 carloads of woodblock and can furnish granite block in any quantity within one week. Any amount of sand and crushed boulders on hand; no paving brick in stock.

New Orleans—About 4,000 bbl. portland cement consumed weekly as compared with 3,000 bbl. one month ago. Stocks sufficient to meet all demands. Tile plants operating within 20 per cent of normal; demand heavy.

Philadelphia—Dealers stocks of sewer pipe low. Demand at this time better than expected. Paving stone and wood blocks used in large quantities, exceptional season anticipated. Cement

CONDITIONS OF MATERIALS STOCKS IN IMPORTANT CENTERS

Stocks on hand in approximate figures, example: (cement, Denver, 10,000 bbl.); time required for delivery of carload lots to city job, example: (sewer pipe, Atlanta, 4 to 5 days); and stocks on hand in general terms, example: (common brick, New Orleans, plenty.)

	Cincinnati	Los Angeles	Atlanta	New Orleans	Denver	Philadelphia	New York	Detroit	Minneapolis
Sewer pipe	8,000 ft.	Plenty	Del. in 4 to 5 days	Ample	24 hr. del. local plant	Stocks low	Enough; del. 24 hr.	Moderate	.....
Cement	15,000 bbl. (Portland) 1,000 bbl. (Utica) (natural)	Sufficient	20 to 25 cars	Demand about 4,000 bbl. weekly. Stocks normal.	10,000 bbl.	Will not stand heavy demand.	70,000 bbl.	Local mills. Stocks lighter.	Del. in 24 hr. Local mills.
Lime (common)	200 tons	.....	10 to 12 cars	Enough	.....	.....	Moderate stock in city.	10 to 15 cars Michigan and Ohio mills.	Del. 24 hr. to 5 days.
Lime (hydrated)	.....	.....	.....	No demand	.....	.....	.....	.....	.....
Common brick	12,000,000 No paving brick.	Yards well stocked	25 to 30 cars	Plenty	Depleted.	Enough yards working full time	16,000,000 Rapidly being sold out.	Ample. Local yards.	Normal
Hollow tile	.....	.....	Ample del. in 3 to 4 days.	About 25 per cent of normal	.....	10 carloads.	Large plants near city; shipments by water.	Small supply; del. takes several days	.....
Lumber	120,000,000 ft.	Yel. pine and spruce not on market.	Plenty	Normal. Replenished from nearby mills.	Ample. 24 local yards.	Demand exceeding supply.	Prompt del.—24 hr.	Sufficient in local yards.	About 75 per cent of normal.
Asphalt	300 tons. Mex. asphalt.	.....	.....	.....	10 carloads.	Plentiful	Refineries near city.	Small	.....

stock sufficient to meet present demands only. Brick yards operating on full time but barely keeping up to orders. Ten carloads of hollow tile on hand all taken up by unfilled orders. Lumber stocks moving out faster than they can be replenished; demand increasing.

Detroit—Ample supply of cement available; stocks on hand show decrease from February. Local and nearby mills can supply demand immediately. Small stocks of asphalt and hollow tile; several days required on large deliveries. Moderate supply of lime and sewer pipe.

Denver—Little change in building materials stocks since last month, with the exception of common brick. Stocks of this important material will be depleted to a considerable extent during April.

Birmingham—Stocks in general at manufacturing plants have been somewhat depleted but in nearly all cases production has been increased sufficiently to make up for the deficit. Most plants are now in shape to take care of the increases in orders.

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted. Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section. The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of April 6; the next, on May 4.

Steel Products:	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Structural shapes, 100 lb.	$2.48	$3.35	$4.00	—$2.38	$2.66	—$3.30	$3.10	$3.25	$3.75
Structural rivets, 100 lb.	3.35	3.90	5.50	—3.00	3.90	—4.45	4.50	3.75	6.50
Reinforcing bars, ¾ in. and larger, 100 lb.	2.38	3.25	3.50	—2.28	2.56	—3.32½	2.75	3.25	2.75
Steel pipe, black, 2½ to 6 in. lap, discount	61%	68%	45%	59½%	61.9-5%	44%	58.8%†	53%	—30.00
Cast-iron pipe, 6in. and over, ton	47.30	+42.50	48.30	43.10	—46.50	52.00	48.00	—51.00	55.00
Concreting Material:									
Cement without bags, bbl.	2.40	2.39	2.25	+1.97	2.24	2.90	2.73	2.94	2.48
Gravel, ¾ in., cu.yd.	1.75	1.85	2.25	2.00	1.50	2.50	2.25	1.50	1.50
Sand, cu.yd.	1.00	1.15	2.25	2.00	1.00	1.10	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd.	1.75	1.90	2.73	1.60	2.25	3.50	2.25	3.00	2.00
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	—48.00	+38.00	33.50	—41.00	38.00	34.75	28.00	20.00	47.00
Lime, finishing, hydrated, ton	15.80@16.80	18.00	25.00	18.00	29.00	24.00	22.00	27.00	21.00
Lime common, lump, per bbl.	2.75@3.18	1.25	2.50	1.40	1.40	2.70	1.75	2.75	11.00
Common brick, delivered, 1,000.	19.40@19.90	+9.00	11.15	11.00	15.00	12.00	—15.00	14.00	16.00
Hollow building tile, 4x12x12, block	Not used	.07975	.115	.0821	.0752	.08	....	+.12	+.095
Hollow partition tile 4x12x12, block	.11120	.06525	.115	.0657	....	.10	.108	.11	.....
Linseed oil, raw, 5 bbl. lots, gal.	—.82@.83	+.90	.109	.90	+.95	—1.05	—.96	.86	1.05
Common Labor:									
Common labor, union, hour.	.75	.35	.....	.80	.....	.50@.55	.56¼	.50@.60	.....
Common labor, non-union, hour.	.....	.20	.25	.72½	.40@.50	.35@.40	.47½@.50	.50	.20@.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given: 45-5% means a discount of 45 and 5 per cent. Charge is 15c. per 100 lb. for cutting reinforced steel into 2-ft. lengths or over.

New York quotations are delivered except tiles, which are "on trucks." Common lump lime per 280-lb. net; both lump and hydrated quoted f.o.b. cars New York. Sand gravel and crushed stone are quoted alongside dock. Cement and steel pipe delivered to contractors on job. Gravel ready mixed $2 per cu.yd.

Chicago quotes hydrated lime in 50-lb. bags; common lump line per 180-lb. net.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed store quoted at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.55 for Sheboygan. Common labor not organized.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to contractors in yards at San Francisco. Lumber price is for No. 1 fir, common.

Seattle quotes on Douglas fir instead of pine. Common lump lime per 180-lb. net. Hollow building tile delivered.

Montreal quotes on fir instead of pine. Sand, stone, gravel and lump lime per ton. Lime and tile are delivered; cement, sand, gravel and stone, on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 97.56 cents). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net.

Changes Since Last Week

Structural shapes are quoted in Denver at $3.30 as against $3.50; rivets at $4.45 reduced from $4.55 and reinforcing bars at $3.32½ as compared with $3.42½ per 100 lb., last week. Mill shipments of steel shapes quoted at $2.80; rivets $2.10 and bars $2.57½ per 100 lb.

Pittsburgh mill price of $1.50 for structural shapes and reinforcing bars continues to gain in firmness; plates, however, are quoted at $1.40@$1.50 per 100 lb.

Downward tendency in cast-iron pipe prices in New York and Chicago; Minneapolis quotes $46.50 as against $47 and Seattle $51 as compared with $52 per ton for 6-in. pipe. Atlanta quotes a rise of $2.55 per ton.

Long leaf yellow pine quoted in New York at $48 as against $49 and in Atlanta at $38 as compared with $36 per M. ft., one week ago.

Common brick down 50c. in San Francisco and up 25c. per 1,000 in Atlanta. Slight advance in hollow tile in Seattle and Montreal.

Lumber, brick and steel pipe prices showing upward trend in Seattle market.

Linseed oil advanced 1c. in Atlanta, 2c. in Minneapolis and declined 3c. in Denver and 8c. per gal. (5-bbl. lots) in San Francisco. Oil is quoted in Denver at $1.03 per gal. in iron barrels; in wooden containers 2c. per gal. extra.

Bricklayers have gone on strike in San Francisco, refusing to work with non-union men on the American or open-shop plan.

General building trades strike called in Niagara Falls, involving 1,200 men. A 10-per cent wage reduction, from the scale specified in an agreement expiring Mar. 31, 1922, was refused by all trades excepting bricklayers. The latter will return to work at a rate of $1.05 per hour.